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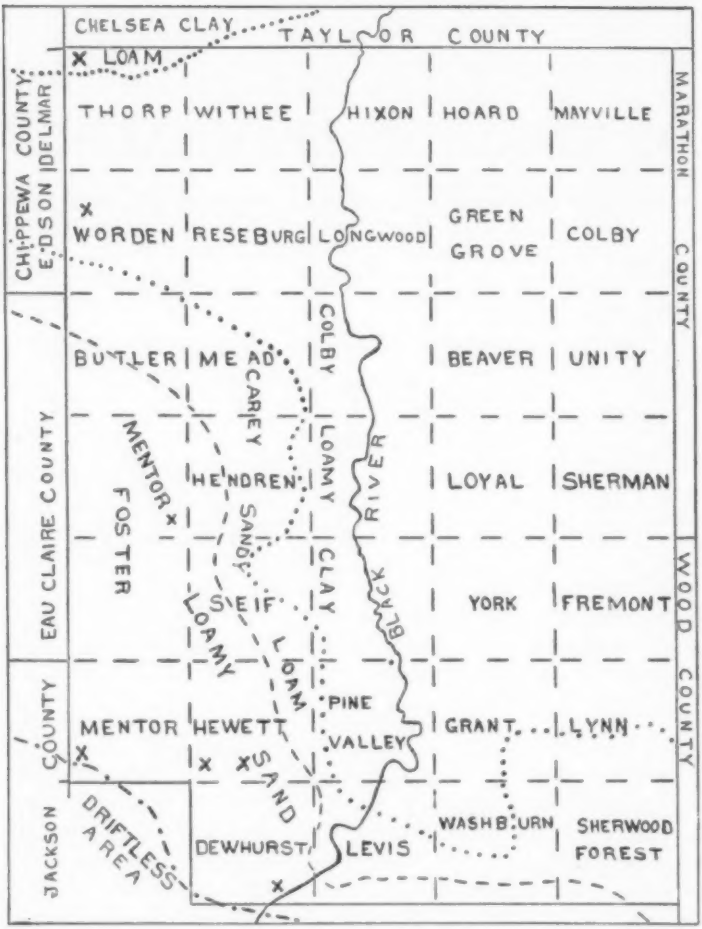
MAMMALS OF WESTERN CLARK COUNTY, WISCONSIN

BY F. J. W. SCHMIDT

INTRODUCTION

During the summers of 1927 and 1928 I collected reptiles, amphibians, and mammals in Thorp, Worden, Foster, Mentor, Hewett, and Dewhurst Townships, in western Clark County, Wisconsin. These locations may be found on the map in Figure 1. My main base was the farm of G. W. Schmidt in Worden Township. The present paper embodies remarks on the distribution of the small mammals in relation to plant associations, physiography, geology, and soil formations, and an annotated list of the mammals of which specimens were obtained. For the purpose of catching salamanders from six to ten pits about two feet across and from two to three feet deep were dug at each collecting base. These pits were a valuable means of securing mammals as well as salamanders and frogs. In them many individuals of *Peromyscus*, *Pitymys*, *Zapus*, *Clethrionomys*, *Sorex*, *Microsorex*, and *Blarina* were taken. The specimens of mammals are now in the University of Wisconsin, the University of Michigan, the Field Museum of Natural History, the American Museum of Natural History, the United States Biological Survey, and the private collections of F. J. W. Schmidt, Jack C. von Bloeker, and Walter Weber. I am indebted to Hartley H. T. Jackson of the United States Bureau of Biological Survey, and to Wilfred H. Osgood and C. C. Sanborn of the Field Museum, for aid in identifying doubtful forms, and to George Wagner and N. C. Fassett of the University of Wisconsin for helpful criticism.



MAP OF CLARK COUNTY, WISCONSIN

Crosses denote the collecting stations in the townships mentioned in the introduction. Border of Mentor loamy sand,----------. Border of Colby loamy clay, ... (After Weidman, 1903, plate 1.)

GEOLOGY AND PHYSIOGRAPHY

All of Clark County, except a few small areas in the southwest corner, is glaciated. Drift of Wisconsin age covers only about four square miles of Thorp Township. This corresponds to the soil designated as Chelsea clay loam on the map. The rest of the county is covered with what is known as the older drift. This drift is generally thick (10 to 150 feet) in the northern and eastern parts of the county, but in the southwestern part it is thin or absent. Cambrian sandstone and shale underlie the drift except along the northern and eastern borders of the county. As glacial drift is generally modified by the underlying bedrock, the southwestern part of the county is very sandy where the bedrock is sandstone and swampy where it is shale. This area is but sparsely settled. The northern and eastern parts of the county, which have a thick covering of glacial drift, have a heavy clay soil well adapted to dairy farming and are well occupied.

According to physical composition there are four recognized soils in Clark County: the Chelsea clay loam, the Colby loamy clay, the Carey sandy loam, and the Mentor loamy sand. The distribution of these soils in Clark County is shown on the map. The present study represents a section across the older drift from the Wisconsin drift in Taylor County to the Driftless Area in Jackson County. As the character of these soils helps to explain the differences in the plant and animal life to be found in this area and as I shall refer to these soils frequently in the following pages, I shall point out their more important characteristics. Soil names are after Weidman (1903).

Chelsea clay loam.—This soil formation represents in Clark County the area covered by the terminal moraine of the Wisconsin drift. A large part of this soil formation is characterized by ridges, and billowy hills associated with kettle holes (depressions left by the melting of buried ice blocks), swamps and small lakes. The surface soil is a clay loam mixed with boulders. The subsoil consists of a mixture of clay and boulders with a small amount of sand. There is very little organic material in this soil and there is rarely more than an inch or two of humus on the surface in the forests.

Colby loamy clay.—This soil formation includes most of the older drift in north central Wisconsin. The subsoil is a heavy clay, formed by the disintegration of the minerals of which the glacial drift was composed. The upper ten inches is a loamy clay well mixed with organic materials. In the forests the upper five or six inches is often almost entirely of organic material. Generally the surface is gently

sloping and well drained. All lakes have been drained or filled and swamps are scarce.

Carey sandy loam.—This soil formation includes a narrow strip of land between the Colby loamy clay and the Mentor loamy sand and is intermediate in character between these two. In this area there are three sandstone mounds west of Greenwood known as North, Middle, and South Mound.

The Mentor loamy sand.—This soil formation includes a large area in southwestern Clark County and extends into Jackson and Eau Claire Counties. The formation has its origin in the disintegration of sandstone with which is mixed a thin covering of glacial drift. The drift consists of clay, boulders, and a large amount of sand derived from the local sandstone. The soils of this formation are therefore very sandy except in the low flat areas which are underlain by shale and in other low places where clay has been washed in. In Dewhurst Township, along the Black River, there is a glacial outwash deposit of sand and gravel. The Mentor loamy sand area in Clark County is characterized by several mounds and buttes of sandstone which rise from 50 to 200 feet above the general level. These are outliers of the escarpment of the upland which extends westward from the vicinity of Black River Falls in Jackson County.

LIFE ZONES

Two of the North American life zones of Merriam are represented in Clark County. The Canadian Zone is restricted to the area of the Chelsea clay loam. The remainder of the county is in the Transition Zone. In Clark County the border of the Canadian Zone is more distinct than in other parts of Wisconsin, as the terminal moraine of the Wisconsin drift has more of an east-west trend in central than in eastern or western Wisconsin and constitutes a physical barrier to the northward extension of certain mammals. The restriction of the Canadian Zone in Clark County to the Chelsea clay loam area in the present paper is not based on the difference in the number of species of Canadian Zone mammals to be found in the Chelsea clay loam and the Colby loamy clay areas, but on the relative number of individuals of the commonest species. Thus in the area of the Chelsea clay loam in number of individuals *Peromyscus maniculatus gracilis* is first, *Clethrionomys gapperi* is a close second, and *Blarina brevicauda talpoides* is third, while in the area of the Colby loamy clay *Peromyscus leucopus noveboracensis* is first, *Blarina brevicauda talpoides* second, and *Pitymys pinetorum*

scalopsoides third. This applies only to the original forest condition, as after the land has been cleared for pasture and cultivation *Microtus pennsylvanicus*, formerly restricted to the swamps and sphagnum bogs, becomes the most numerous mammal. If the division were made on the basis of the number of species it would be necessary to include the area of the Colby loamy clay in the Canadian Zone for there are more Canadian than Transition Zone mammals in this area. On the basis of plants there is a distinct difference between the Chelsea clay loam and Colby loamy clay areas. In the former, hemlock is the dominant plant in the climax association. Weidman (1903, p. 30) says: "The amount of hemlock was generally equal to or greater than that of the combined hard woods." At the present time stands of hemlock are found only in a few local areas that have escaped the fires which followed the lumbering operations during the period between 1890 and 1910. In the Colby loamy clay area hard maple is the dominant plant of the climax association on the ridges and white pine is the dominant plant of the climax association on the lowlands.

THE CANADIAN ZONE

The characteristic forest plants of this zone in Clark County are hemlock (*Tsuga canadensis*), balsam fir (*Abies balsamea*), white cedar (*Thuja occidentalis*), white birch (*Betula papyrifera*), partridgeberry (*Mitchella repens*), fir club moss (*Lycopodium*), shin-leaf (*Pyrola*). Other forest plants include hard maple (*Acer saccharum*), soft maple (*Acer saccharinum*), yellow birch (*Betula lutea*), white pine (*Pinus strobus*), and red pine (*Pinus resinosa*). The bog plants include sphagnum moss (*Sphagnum* sp.), black spruce (*Picea mariana*), tamarack (*Larix laricina*), leather-leaf (*Chamaedaphne calyculata*), pitcher plant (*Sarracenia purpurea*), cranberry (*Vaccinium* sp.), blueberry (*Vaccinium* sp.), and rose pogonia (*Pogonia ophioglossoides*).

The mammals collected in the forest include *Sciurus carolinensis leucotis*, *Sciurus hudsonicus loquax*, *Tamias striatus griseus*, *Eutamias minimus jacksoni*, *Peromyscus maniculatus gracilis*, *Clethrionomys gapperi gapperi*, *Zapus hudsonius hudsonius*, *Sorex cinereus cinereus*, *Microsorex hoyi intervectus*, and *Blarina brevicauda talpoides*. Those collected in a sphagnum bog include *Microtus pennsylvanicus pennsylvanicus*, *Sorex arcticus laricorum*, and *Blarina brevicauda talpoides*. In a hayfield *Microtus p. pennsylvanicus*, *Citellus tridecemlineatus tridecemlineatus*, and *Condylura cristata* were collected. Of the mammals listed above all were collected in the Transition Zone with the exception of *Peromyscus maniculatus gracilis*, and *Sorex arcticus laricorum*. As *Peromyscus maniculatus bairdii* does not occur in the area of the Colby loamy clay the range of this mouse does not meet that of *Peromyscus maniculatus gracilis* in Central Wisconsin, i.e. between the Chippewa and Wisconsin Rivers.

TRANSITION ZONE

In Clark County this zone includes the areas of the Colby loamy clay and the Mentor loamy sand. As these two areas differ distinctly in regard to both plants and mammals I shall list the common plants and mammals of each area separately.

Colby loamy clay.—The common plants of this area include hard maple, white pine, yellow birch, soft maple, red oak (*Quercus rubra*), American elm (*Ulmus americana*), rock elm (*Ulmus racemosa*), red elm (*Ulmus fulva*), blue beech (*Carpinus caroliniana*), iron-wood (*Ostrya virginiana*), basswood (*Tilia americana*), bitternut (*Carya cordiformis*), butternut (*Juglans cinerea*), hazel-nut (*Corylus americana*), beaked hazel-nut (*Corylus rostrata*), dutchman's breeches (*Dicentra cucullaria*), squirrel corn (*Dicentra canadensis*), hepatica (*Hepatica acutiloba*), trillium (*Trillium grandiflorum*), solomon's seal (*Polygonatum biflorum*), wild ginger (*Asarum canadense*), dwarf ginseng (*Panax trifolium*), Greek valerian (*Polemonium reptans*), touch-me-not (*Impatiens biflora*), wild geranium (*Geranium maculatum*), yellow clintonia (*Clintonia borealis*), wild tiger lily (*Lilium michiganense*), yellow dog-toothed violet (*Erythronium americanum*), and yellow violet (*Viola eriocarpa*). Hemlock originally grew in certain parts of the Colby loamy clay area. Weidman (1903, p. 30) says: "Hemlock is an abundant and thrifty growth in northern Wood, northeastern Clark Counties and farther to the east and north." The mammals collected in the forest in the Colby loamy clay area include *Myotis lucifugus lucifugus, Myotis keenii septentrionalis, Lasionycteris noctivagans, Sorex cinereus cinereus, Microsorex hoyi intervectus, Blarina brevicauda talpoides, Condylura cristata, Sciurus hudsonicus loquax, Sciurus carolinensis leucotis, Sciurus niger rufiventer, Glaucomys sabrinus macrotis, Tamias striatus griseus, Marmota monax rufescens, Peromyscus leucopus noveboracensis, Pitymys pinetorum scalopsoides, Clethrionomys gapperi gapperi, Zapus hudsonius hudsonius, Napaeozapus insignis frutectanus, Mus musculus, Sylvilagus floridanus mearnsii, Erethizon dorsatum, Taxidea taxus taxus,* and *Mephitis mephitis minnesotae.* Those collected in hayfields include *Microtus pennsylvanicus, Citellus tridecemlineatus tridecemlineatus* and *Blarina brevicauda talpoides.* Of the above mammals *Condylura cristata, Sciurus niger rufiventer, Tamias striatus griseus, Glaucomys sabrinus macrotis, Pitymys pinetorum scalopsoides* and *Napaeozapus insignis frutectanus* were not collected in the Mentor loamy sand area and probably do not occur in that part of Clark County. Those which do not range into the Canadian Zone in Clark County are *Peromyscus leucopus noveboracensis, Sciurus niger rufiventer,* and *Pitymys pinetorum scalopsoides.*

Mentor loamy sand.—The common plants of this area are black oak (*Quercus velutina*), jack pine (*Pinus banksiana*), red pine, white pine, large-toothed aspen (*Populus grandidentata*), American aspen (*Populus tremuloides*), pin cherry (*Prunus pennsylvanica*), white birch, witch hazel (*Hamamelis virginiana*), sweet fern (*Myrica asplenifolia*), wild columbine (*Aquilegia canadensis*), trailing arbutus (*Epigaea repens*), crowfoot violet (*Viola pedata*), wintergreen (*Gaultheria procumbens*), western red lily (*Lilium philadelphicum* var. *andinum*), kidney liver-leaf (*Hepatica americana*), harebell (*Campanula rotundifolia*), blueberry (*Vaccinium* sp.), highbush blueberry (*Gaylussacia baccata*), and pink corydalis (*Corydalis sempervirens*). The plants growing in the bogs are the same as those listed for the Canadian Zone. The mammals collected in this area include

Scalopus a. machrinus, Microtus ochrogaster, Microtus pennsylvanicus pennsylvanicus, Peromyscus leucopus noveboracensis, Peromyscus maniculatus bairdii, Clethrionomys gapperi gapperi, Zapus hudsonius hudsonius, Sorex cinereus cinereus, Microsorex hoyi intervectus, Blarina brevicauda talpoides, Citellus tridecemlineatus tridecemlineatus, Citellus franklinii, Eutamias minimus jacksoni, Sciurus h. loquax, Geomys bursarius, Mephitis mephitis minnesotae, Mustela vison letifera, Procyon lotor lotor, Canis latrans, and *Lasiurus borealis borealis.* Of these *Scalopus a. machrinus, Citellus franklinii, Geomys bursarius, Microtus ochrogaster,* and *Peromyscus maniculatus bairdii* are restricted, in Clark County, to the Mentor loamy sand area. As the dominant plants in the climax association are jack pine and black oak which form an open woods favorable to grasses and blueberries these prairie mammals were able to adapt themselves to the semi-prairie conditions that they found there. *Citellus tridecemlineatus* is not at present restricted to this area, but it may have been before the coming of the white man. *Microtus pennsylvanicus* did not live in this open woods, but in the sphagnum bogs and cut-grass swamps.

ANNOTATED LIST

All measurements, unless otherwise indicated, are in millimeters and refer to total length, tail, and hind foot, in the order indicated.

Myotis lucifugus lucifugus (Le Conte). Little Brown Bat. Seven specimens from Worden collected in the attic of our house.

Measurements.—Average for seven specimens: Total length 93, tail 37, hind foot 10, ear 13.7, tragus 6.7, wingspread 262.

Myotis keenii septentrionalis (Trouessart). Trouessart's Little Brown Bat. One specimen was collected in the attic of our house in Worden Township.

Measurements.—Total length 91, tail 37, hind foot 7.5, ear 18, tragus 10, wingspread 246.

Parasites.—This bat was parasitized by several fleas and three tapeworms.

Lasionycteris noctivagans (Le Conte). Silvery Bat. One specimen (♂) from Worden Township. This bat was found on September 6 under the grate of the furnace in the cellar of our house. It may have crawled in looking for a place to hibernate. There was a thick layer of fat under its skin.

Measurements.—Total length 100, tail 42, hind foot 11, wingspread 295.

Lasiurus borealis borealis (Müller). Red Bat. One specimen from Foster Township. It was hanging about fifteen feet from the ground on the limb of a red oak.

Measurements.—Total length 105, tail 51, hind foot 10, wingspread 290.

Blarina brevicauda talpoides (Gapper). Short-tailed Shrew. Thirty specimens: Thorp 4, Worden 23, Hewett 3.

Measurements.—Average for 30 specimens: Total length 116.1, tail 24.7, hind foot 14.8. Largest: ♂, total length 131, tail 26, hind foot 15.6, smallest: ♂ juvenile: 104, 23, 14.

Habitat.—These shrews were very abundant in the hardwood and coniferous forests of the Colby loamy clay and Chelsea clay loam areas, but scarce in the Mentor loamy sand area. In the Mentor loamy sand area two specimens were collected in a dense growth of white pine and one on the talus slope of a sandstone butte in a thicket of poplar and jack pine. In Thorp Township two specimens were collected in a sphagnum bog in a thick growth of tamarack. In Worden Township they were found living in hayfields with *Microtus pennsylvanicus*.

Food.—Stomach contents included beetles and the skins of grubs. Several mice which were caught in pits were eaten by these shrews. They no doubt eat young mice as they can kill an adult mouse if it can be cornered and hence a mouse defending its nest would be driven out or killed. One winter I heard a loud squeaking in the snow, and upon investigating found a large meadow mouse fighting a short-tailed shrew. The mouse was nearly dead from loss of blood due to cuts on the neck, but was unable to bite through the tough skin on the neck of the shrew.

Scent glands.—These shrews have scent glands at the base of the tail and on each side back of the front legs Cats catch them to play with but do not eat them because of the scent given off by the shrew. While a cat is playing with them they utter a high-pitched squeak.

Sorex arcticus laricorum Jackson. Southern Saddle-backed Shrew. One specimen (female) from Thorp Township. It was caught in a sphagnum bog under the roots of a tamarack in a trap baited with a mouse.

Measurements.—Total length 118, tail 43, hind foot 14.5.

Sorex cinereus cinereus Kerr. Cinereous Shrew Thirty-three specimens: Thorp 2, Worden 4, Hewett 27.

Measurements.—Average for 33 specimens: Total length 93.6, tail 36.8, hind foot 11.8; largest: 102, 42, 12.5; smallest: 83, 38, 12.

Habitat.—Two were collected in the Chelsea clay loam area in pits under rotten hemlock logs in a hemlock-hardwood forest. Four specimens were caught in pits in a hardwood forest of the Colby loamy clay area. Of the twenty-six specimens from the Mentor loamy sand area thirteen were caught in pits in a growth of white pine, four were caught in traps under tamarack in a sphagnum bog, and nine were caught in pits in a thick growth of poplar, jack pine, and sweet fern growing on a sandy talus slope extending out from the base of a sandstone butte.

Food.—Stomach contents included pieces of beetles, grubs, and ants. Specimens kept in captivity preferred crickets to grasshoppers and grasshoppers to beetles. When two specimens were caught in a pit at night one was usually half eaten before morning. A hole about the size of a pencil was usually made in the side or back and through this the viscera were eaten. Several mice caught in pits had holes eaten in their backs. One shrew ate a hole in the back of a jumping mouse floating in a pit partly filled with water, but during the night the shrew fell off and was drowned. It is evident that the jumping mouse was used as a raft as in another pit a live shrew was found riding on the back of a drowned *Microtus pennsylvanicus*. On the night before four *Microtus pennsylvanicus* and three of these shrews were drowned in this pit. The epidermis on the leg of a jumping mouse, which had been slightly chewed by a *Sorex cinereus* caught in the same pit, peeled

off. Also the epidermis on the head of a pine mouse peeled off after the mouse had been chewed by a *Sorex cinereus* which was caught in the same pit. This indicates that the saliva of shrews may contain an enzyme capable of aiding in the digestion of protein material.

Microsorex hoyi intervectus Jackson. Northwestern Pigmy Shrew. Six specimens: Thorp Township 1, Worden Township 3, Hewett Township 2.

Measurements.—Average of six specimens: Total length 87.5, tail 30.3, hind foot, 10.5; largest: 96, 32, 11; smallest: 79, 28, 10.

Habitat.—In the Chelsea clay loam area one specimen was caught in a hemlock forest in a pit under a rotten hemlock log. In the Colby loamy clay area three specimens were caught in pits in a hardwood forest. In the Mentor loamy sand area one was caught in a pit in a dense growth of white pine and one in a pit in a growth of poplar, soft maple, jack pine, and sweet fern, growing on a sandy talus slope extending out from the base of a sandstone butte.

Food.—The pits in which *Microsorex* were caught were baited with bodies of small mammals. One individual ate more than half of a *Sorex cinereus* during the night and in the morning was eating squirrel intestines which had been buried in the floor of the pit by dung beetles.

Individual characteristics.—One pigmy shrew, as stated above, was found eating the contents of a dung beetle burrow in the floor of a pit. Only its tail and hind legs were visible while it was standing on its head in the burrow made by the dung beetles. The shrew was able to enter the burrow without enlarging it to any extent. A strong odor was noticeable in the pit. The dead *Sorex* had no odor, but after killing the *Microsorex* I noticed that the hair on each side, back of the front legs, was soaked with a yellowish fluid, and this was found to be the source of the odor in the pit. On the inside of the skin there was a reddish gland 12 mm. long and 6 mm. wide, situated 15 mm. back of the base of the front leg. These glands are marked on the outside by a narrow, longitudinal area without much hair.

Scalopus aquaticus machrinus (Rafinesque). Prairie Mole. Two specimens from Hewett Township.

Measurements.—No. 163, male: Total length 188, tail 27, hind foot 23. No. 268, female: 170, 27, 22.5 mm.

Habitat.—The prairie mole is common on the sandy talus slopes extending out from the sandstone cliffs of the mounds, buttes, and mesas of the Mentor loamy sand area.

Food.—Stomach contents included beetles, beetle larvae, fly larvae, and ants.

Condylura cristata (Linnaeus). Star-nosed Mole. Fourteen specimens: Worden, 4, Delmar, Chippewa County, 10.

Measurements.—Average for 14 specimens: Total length 194, tail 78, hind foot 27.85; largest: 205, 82, 28; smallest: 170, 80, 29.

Habitat.—In the Colby loamy clay area star-nosed moles were abundant in hardwood forests in either wet or dry places, but were most abundant along a small creek which runs through the forest. One was killed in a hayfield by a dog. In the Chelsea clay loam area they were very abundant in a hayfield in Delmar

Township, Chippewa County. In this hayfield there are several shallow kettle holes filled with water in wet periods and supporting a growth of cut-grass and cat-tails. From these undrained depressions mole burrows radiate out in all directions into the hayfield.

Food.—Stomach contents: White grubs and earthworms. One was kept alive from September 4 to September 18, when it became necessary to preserve it on account of my leaving for school. This mole ate 1850 earthworms, most of the flesh of 2 mice, a frog, and 3 large June beetle grubs during that time. The mud in the creek bottom along a small creek which flows through a hardwood forest in Worden Township is heavily infested with annelid worms of the order *Microdrili*. When there is water in the creek one end of the worm sticks out of the mud and waves around in the water. They are so numerous in some parts of the creek bottom that they look like a waving growth of brown moss. When the creek dries up they retreat into the mud. During the summer of 1929 this creek bottom, which was partly dried up at that time, was thoroughly rooted up and tunneled by star-nosed moles in search of worms.

Method of eating.—In eating an earthworm the front feet are used to push the worm away from the mouth. This is done rather to keep the worm straightened out than to tear it up. Frequently earthworms were eaten entire, and were rarely broken into more than two or three pieces. Stomach contents of moles killed by traps consisted of broken and whole earthworms, which showed few effects of chewing. Earthworms were often swallowed in five seconds and it rarely took more than ten seconds. In eating the white grub of a June beetle the mole would paw it around until a good hold was secured on the head. It would then chew the grub for four or five minutes. The eating of one grub which I timed took exactly five minutes. In tearing open a young meadow mouse, 80 mm. in length, the mole fastened its front claws in the skin of the mouse and thrust sidewise with palms outward. The lungs, heart, abdominal viscera, and brains of the mouse were eaten. A large frog (dead) was opened by securing a hold with one foot on the angle of the jaw and the other on the pelvic girdle. Once a hole was made it was soon enlarged by additional thrusts of the front feet. The heart, lungs, and liver were eaten, but the stomach was rejected. The skin of the legs was peeled off in the same way and the meat picked from the bones. Both the skin and meat of the back were eaten, while the skin of the legs, abdomen, and neck was rejected. Another frog was opened but no part of it was eaten. Noticing that the teeth were not used in opening either the mouse or the frogs I tried handling the mole and found that there was no danger of being bitten.

Drinking.—A cup of water was placed in the cage on September 5. The mole drank three swallows and then stuck its head under water. On September 6 it was given another cupful of water. It first licked off the drops on the outside of the cup. After this procedure it found the water on the inside, drank several swallows, and then jumped in, but only for a second.

Swimming.—To test its swimming ability I placed the mole in a square-cornered cement tank three feet wide and five feet long. When it came to a corner it would dive down in an effort to find an exit. Failing in this it tried climbing out at the corners. After several unsuccessful attempts it succeeded in climbing up about two feet to the rim of the tank. In swimming the front feet were brought up to the nose with the palms out and then thrust back. The hind feet are moved

in unison with the front feet, but they do not play as great a part in swimming as the paddle-shaped front feet. The tail is not used in swimming. The first thing the mole did upon getting out of the water was to scratch itself. At first I thought this was done on account of itching, but closer observation showed that it was to fluff up the hair in order to make it waterproof. In trying to reach its back it often rolled over on its side while scratching.

Digging.—In shoving dirt through a hole either horizontally or vertically the mole pushes it along with its front feet and shoulders. One was caught in a pocket gopher trap which was set off by having dirt shoved against the trigger. As the mole's head was toward the trigger it is evident that the dirt was being shoved along ahead of it. The specimen which was kept in captivity was provided with three separate divisions in its cage. One part, 12 by 24 inches, was used for feeding, one part 8 by 10 inches was filled with leaves for sleeping, and the other, 24 by 12 inches, was filled with dirt to a depth of 8 inches. In this dirt a tunnel was made with an opening at each end. When alarmed it would dive into one of these openings head first. The tunnel was enlarged by shoving dirt out through the openings. This work was completed on September 12, and on September 13 the leaves from the nest chamber were carried into the tunnel one by one. As soon as the leaves were all moved, one entrance to the tunnel was plugged up. Dirt was shoved into the opening with the front feet and shoulders. At first, before the dirt became solidly packed, the nose would break through the dirt which was being pushed up. In making a horizontal tunnel through loose dirt or mud the loose dirt is packed against the ceiling. The front feet can be brought up above the back so that a double row of tracks is made on the ceiling of the tunnel These tracks, which I examined on a section of tunnel, were about one third of an inch apart in each row. In hayfields, tunnels are made just below the sod and a small pile of dirt is generally shoved out through a vertical hole every rod or two. One that was caught in a pocket gopher trap in Worden Township had been making a system of tunnels in a hardwood forest. There had been no rain for several weeks and the ground was dry to a depth of about 18 inches. To reach the earthworms which had burrowed down to moist soil the mole made several tunnels penetrating deep into the clay. In an area about 20 by 30 feet, 16 piles of clay, each about 8 inches high and 15 inches in diameter, were built up between August 15 and August 24. Horizontal tunnels measured 50 mm. wide and 40 mm. high. Vertical tunnels measured 50 x 50 mm.

Nest.—Two nests were found in hardwood forest in Worden Township. Both nests were on knolls about one foot above the water of a ditch which carried the water from the road through the woods. The nest chambers were three or four inches from the surface and were five inches wide and three to four inches high. Both nests were placed between roots of maple trees. One nest had two horizontal tunnels entering its chamber, and the other had one horizontal and one vertical tunnel coming up from below. The tunnels measured 40 mm. by 50 mm. in diameter. A mouse trap set in a tunnel coming from the nest caught a mole. One nest was made of maple leaves lined with small pieces of leaves, the other, of leaves and grass.

Individual characteristics.—When the projections on the nose were touched the mole took no alarm, but if the back were touched it dived at once into its hole. When handled it never tried to bite, but continually tried to crawl through the

fingers by shoving them apart with its front feet. When put down after handling it would start eating at once. When sleeping this mole made a peculiar wheezing noise with each inhalation. In depositing feces the hind legs were braced against the side of the box and the feces were discharged against the vertical surface. Feces were always deposited in the same place, which suggests that in the wild state a special burrow may be used for this purpose.

Sciurus hudsonicus loquax Bangs. Red Squirrel. Eighteen specimens: Worden 11, Thorp 4, Foster 1, Hewett 1, Dewhurst 1.

Measurements.—Average for 18 specimens: Total length 313, tail 129.5, hind foot 48.2; largest: 341, 148, 48; smallest: 275, 115, 46.

Habitat.—Red squirrels were abundant in both hardwood and pine forests.

Food.—Stomach contents of one consisted of choke-cherries, 10 per cent, green leaves, 10 per cent, and maple seed, 80 per cent. I have seen them feeding on the seeds of ironwood, hard maple, soft maple, white pine, red pine, jack pine, and yellow birch. In the fall they are often seen carrying acorns, bitternuts, and butternuts.

Sciurus carolinensis leucotis (Gapper). Gray Squirrel. Five specimens: Thorp 1, Worden 4.

Measurements.—Average for five specimens: Total length 493, tail 225, hind foot 69.8; largest: 523, 230, 70; smallest: 462, 217, 69.

Habitat.—Gray squirrels were abundant in the hardwood forests of the Colby loamy clay area and in the hemlock-hardwood forest of the Chelsea clay loam area.

Sciurus niger rufiventer (Geoffroy). Fox Squirrel. Two specimens from Worden.

Measurements.—Total length 520, tail 254, hind foot 73; and 565, 280, 78.5.

Habitat.—In Clark County fox squirrels were found only in the hardwood forests of the Colby loamy clay area.

Marmota monax rufescens Howell. Woodchuck. One female specimen, Worden Township.

Measurements.—Total length 530, tail 120, hind foot 80 mm.

Food.—The Woodchucks feed on grass, clover, and other vegetable matter. Where they are abundant they do considerable damage in hayfields by digging holes and trampling down grass.

Glaucomys sabrinus macrotis (Mearns). Flying Squirrel. One specimen without measurements, Worden Township.

Habitat.—Forests and wooded pastures.

Food.—During the summer of 1917 I collected moths on a birch tree which had been tapped by sapsuckers. Every night during August and September one or more flying squirrels arrived just before dark to drink sap. In several places the squirrels gnawed out the bark between adjacent holes in order to make it easier to lick up the sap. After licking up the available sap they would disappear. Later in the night either the same, or different ones, would come around to continue their operations. In taking sap they hung head down as often as head up.

I once caught one in January in a weasel trap baited with "Funsten" mink bait. One winter a flying squirrel lived in our kitchen for several weeks. It had come down from the attic to sleep in a drawer in the cupboard. On several occasions it was seen licking up sugar and syrup in the pantry. It was also fond of skimmed milk and drank out of a straight-sided fifteen gallon can by hanging to the edge with its hind legs.

Citellus tridecemlineatus tridecemlineatus (Mitchill). Thirteen-striped Spermophile; "Gopher." Eleven specimens: Thorp 1, Worden 2, Foster 2, Hewett 4, Dewhurst 2.

Measurements.—Average for 11 specimens: Total length 248.5, tail 89.4, hind foot 35; largest: 273, 97, 36; smallest: 205, 79, 34.

Habitat.—Pasture and open woods. Along fences between cultivated fields.

Food.—In pastures they feed principally on grass and clover. Stomach contents of several individuals: grass seed and blueberries; six highbush blueberries, grass seed, and roots; four highbush blueberries, grass seed, and one geometrid caterpillar; grass leaves, one geometrid caterpillar.

One specimen examined had twelve mammae.

Citellus franklinii (Sabine). Franklin Spermophile; "Gray Gopher." One specimen from Hewett.

Measurements.—Total length 373, tail 132, hind foot 54 mm. ♂.

Habitat.—This individual was living in brush consisting of poplar, soft maple, and jack pine, in which there were a few open spaces grown up to sweet fern and blueberries.

Food.—Stomach contents: highbush blueberries 20 per cent, blueberries 30 per cent, white roots 50 per cent. There were several nematode parasites in the stomach.

Eutamias minimus jacksoni Howell. Little Chipmunk. Seventeen specimens: Dewhurst 15, Hewett 1, Thorp 1.

Measurements.—Average for 17 specimens: Total length 187, tail 81, hind foot 30; largest: 222, 86, 31; smallest: 161, 70, 29.

Habitat.—In Dewhurst Township little chipmunks were very common along the sandy beaches of the Black River and Arnold Creek. Their burrows were under jack pines and red pines which had been uprooted, or which had tipped toward the beach after being undermined by wave action. In Hewett they were living among the rocky cliffs of the numerous standstone buttes and mounds. In Thorp Township they were found in pastures grown up to blackberry and hazelnut.

Food.—Several were caught in mouse traps baited with scratch feed. Stomach contents: seeds, grass leaves, roots, beetles, and ants.

Number of mammae.—Three specimens examined had eight mammae each. Not more than five young were caught in any one burrow.

Tamias striatus griseus Mearns. Gray Chipmunk. Eight specimens. Worden 6, Thorp 2.

Measurements.—Average for seven specimens: Total length 269, tail 103, hind foot 37; largest specimen: 275, 101, 35; smallest: 258, 99, 38.

Habitat.—Hardwood and pine forests of the Colby loamy clay area and hemlock-hardwood forest of the Chelsea clay loam area. They are also found in wooded pastures in thickets of raspberry, blackberry and hazelnut. None of these chipmunks were seen in the Mentor loamy sand area.

Food.—Several specimens were caught in traps baited with prunes. One that lived near our house in Worden carried several handfuls of soy beans into its burrow. Individuals living near the chicken house carried off large quantities of scratch feed. The cheek pouches of one contained choke cherry stones, 90 per cent, and snails, 10 per cent; of another one, star mushroom and one bulb about three fourths inch in diameter. In the fall they are often seen gathering hazelnuts and basswood seeds.

Number of Mammae and Young.—Two specimens had eight mammae each. One examined on August 15 was found to contain six embryos. One of these embryos measured as follows: 37, 7, 5.5 mm. The hind foot is longer in proportion to the tail than in the adult. This is also true of the mice which I measured (see measurements of young under *Microtus ochrogaster*, *Pitymys*, and *Peromyscus leucopus noveboracensis*)

Microtus pennsylvanicus pennsylvanicus (Ord). Meadow Mouse; Vole. Twenty-one specimens: Worden 5, Foster 3, Hewett 8, Dewhurst 1, Thorp 4.

Measurements.—Average for 20 specimens: Total length, 159, tail 44, hind foot 20.4; largest: 193, 49, 21; smallest: 128, 35, 20; juvenile: 75, 17.5, 12.5.

Habitat.—Meadow mice were collected in hayfields, pastures, cut-grass swamps, and sphagnum bogs. In the bogs their runways were most numerous just above water level. In the cut-grass swamps runways are often partly filled with water.

Food.—Stomach contents of specimens collected in hayfields consisted of the roots and leaves of grasses and clovers. In Thorp Township these mice were abundant in a thick growth of quack-grass. In Foster the stems of marsh-grass were cut into pieces from one half to two inches in length and left in the runways or put in small piles.

Nests.—Nests made of grass of medium coarseness and lined with fine grass are often found in thick grass, or under stones and logs. A nest from Thorp Township measured 130 by 125 mm. on the outside and 70 by 65 mm. on the inside.

Number of Mammae.—One from Dewhurst had four pectoral and four inguinal mammae. The nest of this mouse contained four young.

Enemies.—The stomach contents of three fox snakes (*Elaphe vulpina*) from Hewett consisted of the remains of several of these mice.

Microtus ochrogaster (Wagner). Prairie Meadow Mouse. Twelve specimens: Foster 10, Dewhurst 2.

Measurements.—Average for seven adult specimens: Total length, 135, tail 30, hind foot 17.5; largest adult: 138, 33, 19; smallest adult: 127, 27, 16; average of three juvenile specimens from the same burrow: 96, 21, 15.7; average of two juvenile specimens from Dewhurst Township: 103.5, 25, 17.

Habitat.—Sandy plains and sandy slopes of sandstone mounds in Foster Township; in Dewhurst Township, woods of jack pine and black oak. In both of these habitats there is no heavy covering of grass. This probably explains why there are no *Microtus pennsylvanicus* living with *Microtus ochrogaster* in the Mentor

loamy sand area, while in Illinois both species are often found where there is a thick growth of grass..

Food.—Stomachs of specimens from Foster Township contained roots and stems of grass.

Nests.—In Foster Township a nest was found in a hollow at the end of a pine log, and another under the log; in Dewhurst Township an underground nest was found. Nests were made of fine grass and measured 130 mm. on the outside and 70 mm. on the inside. The underground nest chamber was four inches below the surface in sand, and was 100 mm. wide, 150 mm. long and 90 mm. high.

Burrows.—Burrows in Foster Township were mostly underground. The surface burrows were made by gnawing out the roots of the grass and arching the grass over the shallow excavation. Burrows dug into the sand were generally made in knolls. Burrows made by adults measured 35 mm. in diameter, and those made by young 96 mm. in length measured 20 mm. in diameter. In Dewhurst Township, in jack pine and black oak woods, surface burrows were made under the leaves.

Colonies.—In Foster Township those mice which were living on the flat plain extending out from the bases of the sandstone mounds were concentrated in a few of the large knolls formed by the uprooting of trees. In one knoll two adult males, one adult female and two young were caught. In another knoll two adult males, two adult females, and four young were caught. Both of these knolls were riddled by the burrows of both the old and the young mice. In none of the adjacent knolls were there any burrows or other signs of mice. On the slope of the sandstone mound with a thicker covering of grass, most of the knolls showed signs of burrowing, and the knolls were connected by a network of runways under the grass. A trap set here on one side of a knoll caught a mouse while I was setting a trap on the other side.

Pitymys pinetorum scalopsoides (Audubon and Bachman). Pine Mouse; Mole Mouse. Thirty-four specimens from Worden Township.

Measurements.—Average for 29 adult specimens: Total length 120, tail 21, hind foot 17.7; largest adult: 132, 25, 18; smallest adult: 102, 18.5, 17.5; average of five juveniles ranging from 80 to 95 mm. in length: 86, 15.3, 16.

Habitat.—Pine mice were found only in the hardwood forests of the Colby loamy clay area. No traces of them could be found in cultivated fields, pastures, or orchards. C. C. Sanborn, of the Field Museum, has collected these mice in a hardwood forest on Clay soil at Highland Park, Illinois. In Wisconsin they have not as yet been collected outside of Clark County.

Food.—As pine mice are strictly burrowing animals, their natural food consists almost entirely of roots. Stomach contents of several consisted of a finely chewed white tuber or root. In one burrow a pile of tubers of dutchman's breeches was found. Mice kept in captivity ate the tubers of dutchman's breeches, but preferred a white tuber about one inch long and one fourth inch in diameter, not yet identified. Rootstalks of solomon's seal and wild ginger were not eaten. One mouse was kept for a month on a diet of potato, and was in good health when I killed it. It was offered water several times, but always refused to drink, an indication that water is not necessary where succulent roots are available.

Nests and burrows.—Two nests were located in pine mouse burrows two inches below the surface. There were no young in these nests but traps set at the

entrances of the nests caught both adults and half grown young. These nests had an outside measurement of 100 mm., and were constructed of maple leaves. Two young mice 83 mm. in length built a nest of leaves and moss in their cage.

Burrowing is carried on from the surface to a depth of eight or ten inches according to the amount of loam overlying the clay. The surface burrows are constructed just below the leaves, and they often form a network covering several square rods. From these burrows under the leaves other burrows penetrate the soil. Dirt brought up from below is left under the leaves in piles four or more inches in diameter and two or three inches high. As the leaves form a tough layer the dirt rarely breaks through above the leaves. This distinguishes the mounds from those of *Condylura cristata*, which are piled up on top of the leaves or grass. In diameter the burrows of pine mice are 30 to 35 mm. wide and 25 to 30 mm. high. Pine mice burrow both by day and night. Traps set in burrows where they were active were generally covered up with dirt within a few hours after being set. Mice caught shoving out dirt were always coming out head first, indicating that the dirt is pushed out ahead of the mouse.

Individual characteristics.—One individual was moulting on September 8. The new hair extended farther back on the ventral surface than on the back; another, a young mouse 80 mm. in length, was kept alive for three days. When picked up by the back of the neck it did not struggle and when held in the hand it did not try to bite. It often sat down and combed its whiskers with its front claws. I tried to get some tracks by putting ink on its feet, but it ran along on its front feet dragging its hind feet along behind with the soles up. When its feet were dry it ran about the same as a *Microtus pennsylvanicus*. It never tried to jump out of its cage. A nearly full-grown mouse spent most of its time, when not sleeping, trying to jump out of its cage, which was eight inches high. At the end of sixteen days it succeeded in jumping out, and I then had to put it in a different cage. Unlike the young mouse it had a vicious temperament and would jump at one's fingers trying to bite them.

Clethrionomys gapperi gapperi (Vigors). Red-backed Mouse. Nineteen specimens: Worden 3, Hewett 8, Thorp 8.

Measurements.—Average for 19 adult specimens: Total length 125, tail 32, hind foot 18; largest: 140, 36, 18.5; smallest: 103, 24, 18.

Habitat.—In Hewett, *Clethrionomys* was found in thick brush consisting of poplar, soft maple, jack pine, pin cherry, and sweet fern, growing on the sandy talus slopes extending out from the bases of sandstone mounds and buttes, and in black spruce growing in bogs. In the hardwood forest of the Colby loamy clay area they were scarce. In the hemlock-hardwood forest of the Chelsea clay loam area they were very abundant.

Number of Mammae and Young.—Every specimen examined had eight mammae, and one contained six embryos on August 25th.

Parasites.—In Thorp Township these mice were infested on the ears and head with small mites. On one specimen a patch of bone on the top of the head was exposed where these mites had destroyed the skin. Mice from Worden and Hewett were not infested.

Peromyscus leucopus noveboracesis (Fischer). Northern White-footed Mouse; Deer Mouse. Twenty-six specimens: Worden 8, Foster 3, Hewett 5, Dewhurst 10.

Measurements.—Average for 26 specimens: Total length, 161, tail 72, hind foot 20.6; largest: 200, 90, 21; smallest: 125, 61, 20.

Habitat.—In Worden Township these mice are very abundant in the hardwood and pine forests of the Colby loamy clay area. They do not occur in the area of the Chelsea clay loam. In Foster, Hewett and Dewhurst Townships in the Mentor loamy sand area they are abundant on the sides and tops of the sandstone mounds and buttes wherever there are trees or brush. They rarely occur in sphagnum bogs, but one specimen was collected in a bog about forty rods from the edge.

Number of Mammae and Young.—One from Dewhurst Township, 200 mm. in length, had six mammae, of which four were inguinal and two pectoral. The distance between the inguinal mammae was 10 mm., and between the inguinal and pectoral groups, 40 mm. This specimen contained six embryos on July 1. Average measurements of six embryos: Length 40, tail 11.5, hind foot 5.5.

Enemies.—A fox snake (*Elaphe vulpina*) collected in Dewhurst Township had one of these mice in its stomach.

Peromyscus maniculatus bairdii (Hoy and Kennicott). Prairie White-footed Mouse. One male specimen from Foster Township.

Measurements.—Total length 135, tail 57, hind foot 18. This specimen had the coloration of an adult *Peromyscus leucopus noveboracensis* and at first was thought to be this species, but after collecting *Peromyscus m. bairdii* in Waupaca County with similar measurements and coloration I changed my decision. This identification was verified by H. H. T. Jackson of the United States Bureau of Biological Survey.

Habitat.—This specimen was caught in a sandy plain in which there are only scattering trees and a thin growth of sweet fern, blueberries, and grass. *Microtus ochrogaster*, and *Citellus tridecemlineatus* were living in the same habitat. In a nearby cut-grass swamp *Microtus pennsylvanicus* was abundant, but no traces of this mouse were found outside of the swamps.

Peromyscus maniculatus gracilis (Le Conte). Canadian White-footed Mouse. Fifteen specimens from Thorp Township.

Measurements.—Average for 15 specimens: Total length 183, tail 91, hind foot, 22.3; largest: 205, 102, 22.3; smallest 162, 79 21.2.

Habitat.—Hemlock-hardwood fo[illegible] of the Chelsea clay loam area.

Number of Mammae.—Every specimen examined had four inguinal and two pectoral mammae. On one, 205 mm. in length, the distance between the inguinal mammae was 9 mm.; that between the inguinal and pectoral group, 33 mm. It may be noticed that there is a considerable gap between the inguinal and pectoral mammae in *Peromyscus leucopus noveboracensis* and *Peromyscus maniculatus gracilis*, while in *Zapus hudsonius* the mammae are nearly equally spaced.

Zapus hudsonius hudsonius (Zimmermann). Hudsonian Jumping Mouse. Thirteen specimens: Thorp 2, Worden 2, Hewett 9.

Measurements.—Average for 13 specimens: Total length 207, tail 123, hind foot 29.2; largest: 220, 132, 30; smallest: 185, 110, 28.

Habitat.—In the Chelsea clay loam area one was collected in a hemlock-hardwood forest and one in a swamp under the roots of a tamarack. In the Colby loamy clay area two specimens were collected in a hardwood forest. In Hewett Township one was caught in a dense growth of white pine, one on an island in a creek, and seven in brush consisting of poplar, soft maple, jack pine and sweet fern growing on the sandy talus slope of a sandstone butte.

Food.—Stomach contents consisted of finely chewed roots, often mixed with dirt. Two specimens from Hewett had eaten several yellow geometrid caterpillars that feed on the sweet fern.

Number of mammae.—No. 344 from Thorp Township, 216 mm. in length, had four inguinal and four pectoral mammae. The distance between the inguinal, between the inguinal and pectoral, and between the pectoral was 15 mm.

Napaeozapus insignis frutectanus Jackson. Woodland Jumping Mouse. One female specimen from Worden, now in the American Museum of Natural History collection.

Measurements.—Total length 219, tail 137, hind foot 30.

Habitat.—This mouse was caught in a hardwood forest in a pine mouse burrow in a trap which had been covered with a canvas.

Food.—Stomach contents consisted of finely chewed roots and closely resembled the stomach contents of *Pitymys* caught in the same burrow.

Mus musculus Linnaeus. House Mouse. One male specimen from Worden.

Measurements.—Total length 150, tail 72, hind foot 18.

Habitat.—Generally found in houses, barns, granaries and warehouses. This specimen was caught in a hardwood forest eighty rods from the farm buildings.

Geomys bursarius bursarius (Shaw). Pocket Gopher. Five specimens from Mentor.

Measurements.—Average of five specimens from Mentor Township: Total length 288, tail 86, hind foot 36; largest: 305, 91, 38; smallest: 280, 78, 34. Average of four specimens from Anson Township, Chippewa County: 254, 75, 33.

Habitat.—Pocket gophers were abundant in alfalfa fields and in truck gardens. In Clark County they are abundant only in Mentor Township near Humbird.

Food.—Stomach contents of five specimens consisted of alfalfa roots.

Ondatra zibethica zibethica (Linnaeus). Muskrat. One skull from Worden Township.

Erethizon dorsatum dorsatum (Linnaeus). Porcupine. One skull from Worden. The quills of a dead porcupine were found under a ledge of a sandstone butte in Hewett Township.

Sylvilagus floridanus mearnsii (Allen). Cotton-tail Rabbit. One male specimen from Foster Township.

Measurements.—Total length 352, tail 47, hind foot 87 (not full grown).

Parasites.—This rabbit had several dipterous larvae in the skin of the neck.

Lepus americanus phaeonotus Allen. Snowshoe Rabbit. One male specimen from Hewett Township.

Measurements.—Total length 540, tail 45, hind foot 130.

Habitat.—This was collected on the slope of a sandstone mound in a black oak woods in the Mentor loamy sand area. Tracks of snow-shoe rabbits were seen in sphagnum bogs grown up to tamarack and black spruce in the Chelsea clay loam area.

Parasites.—As I was walking along a logging-road this rabbit jumped out of the brush, ran along the road for three or four rods, and then rolled over and began kicking its feet in the air. There were no internal parasites, so far as could be determined. There were many fleas and most of them were concentrated on the head and neck. On the ears there were 27 large wood ticks, and the skin of the neck was infected with dipterous larvae. These parasites may have weakened the rabbit to such an extent that its exertion in trying to escape caused it to collapse. According to Dr. C. A. Herrick of the University of Wisconsin, the rabbit probably collapsed as a result of tick paralysis.

Mephitis mephitis minnesotae (Brass). Skunk. One specimen from Hewett, and one skull from Worden.

Measurements. Female juvenile: Total length 555, tail 235, hind foot 64.

Habitat.—Forest, open woods, pasture.

Food.—Stomach contents consisted of beetles and grasshoppers. I have seen a skunk eating grasshoppers at five A.M., at which time the grasshoppers were stiff from the cold and easily caught. A skunk once killed a chicken in our chicken-house and was caught the next night in a trap set in the chicken-house doorway.

Taxidea taxus taxus (Schreber). Badger. One mounted specimen from Worden.

Mustela vison letifera Hollister. Mink. One skull from Hewett.

Procyon lotor lotor (Linnaeus). Raccoon. One skull from Hewett.

Canis latrans Say. Prairie Wolf. One skull from Hewett.

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CHARACTERS USEFUL IN DETERMINING THE POSITION OF INDIVIDUAL TEETH IN THE PERMANENT CHEEK-TOOTH SERIES OF MERYCHIPPINE HORSES

By Francis D. Bode

INTRODUCTION

Cheek-teeth of fossil horses display structural characters which have long been recognized as of considerable value in establishing the relationships of these forms and in furnishing suggestions as to the age of the deposits in which the fossils occur. In later Cenozoic formations of western North America where complete skulls and skeletal materials are not always available, identification of members of the Equidae is often based on single teeth.

In the study of an individual hypsodont equine tooth difficulty is frequently encountered in determining with certainty its position in the cheek-tooth series. Variation in the enamel pattern as exhibited by the molars and premolars makes it particularly desirable to know where an individual tooth belongs in the series.

The problem of identifying teeth when detached from jaws arose in the study of a large number of merychippine teeth secured by the California Institute in the *Merychippus* Zone of the north Coalinga region, California. The collections from this Miocene horizon include approximately two thousand separate horse teeth, representing principally the species *Merychippus californicus* Merriam. While characters which assist in determining the position of a tooth apply particularly to this species, the criteria on which identification is made are applicable to individual teeth in a number of generic types of horses from the later Cenozoic.

The problem was suggested by Dr. Chester Stock under whose supervision it was investigated. The writer wishes to express his thanks to Dr. Stock for his kindly guidance during the course of the study. The illustrations have been prepared by Mr. John L. Ridgway.

CHARACTERS AND DEFINITIONS

The position of a tooth in the maxillary or ramus and the angle which its vertical axis makes with the plane of the occlusal surface of the series governs in large measure the attitude of the surface of wear as seen in external view. As is shown in figure 1, the plane of the occlusal surface truncates the crown of each tooth in the series at a slightly

different angle. These angles rarely vary beyond certain characteristic limits. Consequently they furnish a reliable means by which the position of individual permanent cheek-teeth in practically all of the later Tertiary horses can be definitely established.

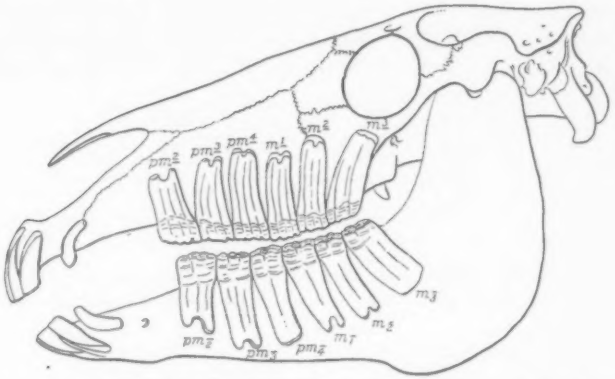

FIG. 1. Lateral view of skull and jaw of modern horse (*Equus caballus* Linnaeus) showing position of cheek teeth in maxillary and ramus, and characteristic angles at which plane of occlusal surface truncates crown of each tooth.

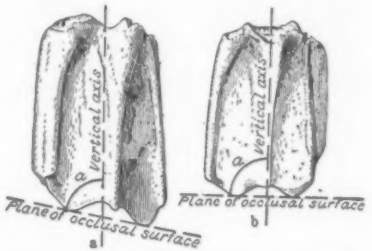

FIG. 2. Lateral views of cheek-teeth of *Merychippus californicus* Merriam showing position of vertical axis, plane of occlusal surface, and angle of slope (a). Fig. 2*a*, P^4; fig. 2*b*, M^1.

In the superior cheek-tooth series the premolars are differentiated from the molars by the relative breadth of the parastyle when compared with the mesostyle (fig. 3). The parastyle of a premolar tooth is noticeably broader than the mesostyle. In a molar tooth these two styles are

subequal in size. This character is of general application. A broad parastyle is indicative of a premolar tooth in practically all of the genera of horses with hypsodont teeth.

The vertical axis of the crown is an imaginary line passing through the center of the occlusal surface and the center of the base of the crown (fig. 2). The slope of the occlusal surface refers to the downward slant of this surface, in either direction, when the tooth is held in a vertical position. A superior cheek-tooth is held with its occlusal surface

FIG. 3. Occlusal views of superior premolars of *Merychippus californicus* Merriam showing breadth of parastyle when compared to mesostyle. Fig. 3*a*, P^3; fig. 3*b*, P^4.

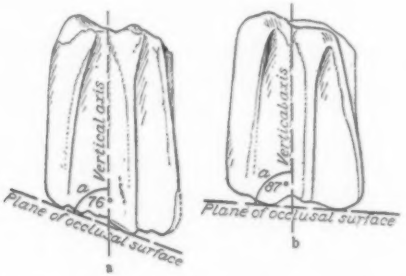

FIG. 4. Lateral views of superior premolars of *Merychippus californicus* Merriam showing difference in angle of slope in P^3 (fig. 4*a*) and P^4 (fig. 4*b*).

facing downward, and an inferior tooth with its occlusal surface facing upward. The angle of slope of the occlusal surface is the anterior angle between the occlusal surface and the vertical axis of the crown (fig. 2). The angle of slope can not be determined in an unworn tooth.

The anteroposterior-transverse ratio is obtained by dividing the anteroposterior diameter of the occlusal surface by the transverse diameter.

SYSTEM OF MEASUREMENTS

All measurements are made exclusive of cement. Whenever possible the system of measurements suggested by J. C. Merriam[1] is used. In both the upper and lower cheek-teeth the angle of slope is measured by a goniometer so constructed that the base of the instrument can rest upon the entire occlusal surface. The anterior angle between the plane of the occlusal surface and a vertical line along the center of the external side of the tooth is the angle of slope (fig. 2). This vertical line corresponds to the external projection of the vertical axis and does

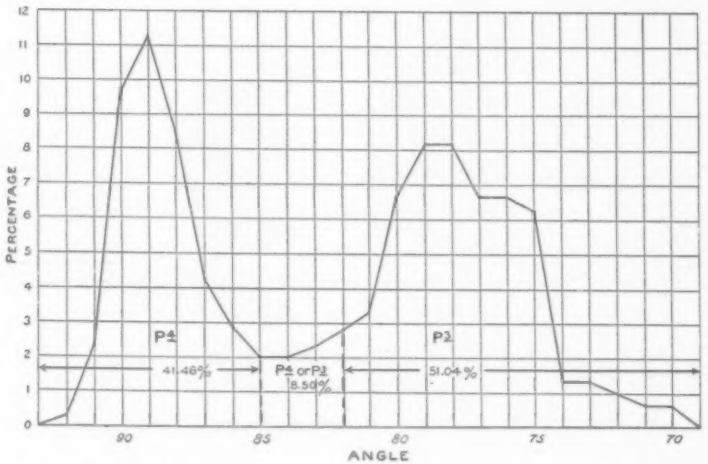

FIG. 5. Graphic representation of the frequency of occurrence of specific angles of slope in P^3 and P^4.

not usually coincide with the column of the mesostyle. Erroneous values are almost certain to be obtained if the attitude of this column influences the measurements.

In superior cheek-teeth the anteroposterior diameter is the distance across the occlusal surface from the middle of the faces of contact of the adjoining anterior and posterior teeth. This diameter does not include the anterior projection of the parastyle in advance of the principal contact plane of the tooth. The anteroposterior diameter in the

[1] Univ. Calif. Pub., Bull. Dept. Geol., vol. 7, no. 21, p. 409, 1913.

inferior cheek-teeth is measured from the middle of the contact plane of the anterior wall of the crown to the extreme posterior projection of the entostylid.

The transverse diameter of the upper cheek-teeth is measured from the deepest indentation of the paracone wall to the farthest lingual projection of the protocone. In the inferior series the transverse diameter is the greatest distance measured between the protoconid and the metaconid. With an unworn tooth the measurements are taken one-third of the distance from the summit to the base of the crown. When the enamel is covered with cement the diameters can not be accurately measured. The data for each of these frequency curves were obtained from more than 200 teeth.

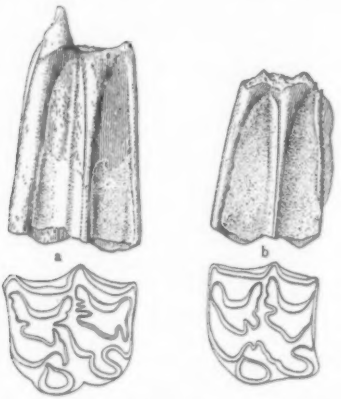

FIG. 6. Lateral and occlusal views of P^4 (fig. 6*a*) and M^1 (fig. 6*b*) of *Merychippus californicus* Merriam showing difference in breadth of parastyle.

SUPERIOR CHEEK-TEETH

The outstanding characters exhibited by P^2 and M^3 afford a ready identification of these teeth. The great enlargement of the parastyle and the pointed anterior wall of the crown of the tooth distinguish P^2 from all other teeth in the superior dentition. Likewise in M^3 the extreme backward curvature of the vertical axis from the plane of the occlusal surface, the indentation of the posterior wall, and the absence of a surface of attrition caused by wear of a more posterior tooth, permit an identification of the last molar without much difficulty.

The broad parastyle of the premolars, figure 3, furnishes a distinguishing feature for these teeth.[2] The distinctive breadth of the parastyle is shown not only on the occlusal surface but also on the outer side by the broadness of this style when compared to the column of the mesostyle. The angle of slope of the occlusal surface serves to separate P^3 from P^4 but is not of value in distinguishing P^4 from M^1. This angle varies from 92° to approximately 70° in premolar teeth. The third

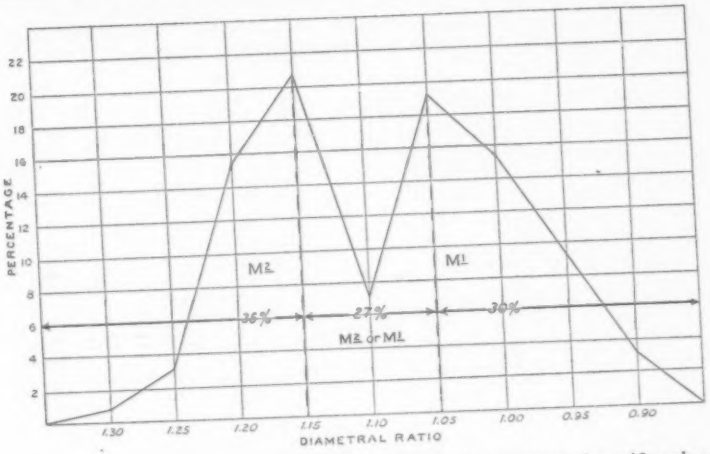

FIG. 7. Graphic representation of the frequency of occurrence of specific values of the anteroposterior-transverse ratio in M^1 and M^2.

premolar is characterized by an angle of slope of 82° or less. This angle has a range from 92° to 85° in fourth premolars. A tooth whose angle of slope lies between 85° and 82° can not be definitely placed in its correct position in the premolar series although it is probable that

[2] In the upper premolars the mesostyle also is usually more prominent than in the molars, especially in *Equus* and genera of the late Tertiary.

Difference in the position of the adjacent horns of the cement lakes, as observed in the molars and premolars, is also an aid in determining the allocation of isolated teeth in horses. In the molars the horns of these cement lakes are usually subequal. In the premolars the anterior horn of the posterior lake extends outward and forward well beyond the posterior horn of the anterior lake.

Still another determining factor is the fact that, in general, the upper premolars of horses have a relatively greater antero-posterior diameter than molars belonging in the same cheek tooth series.—J. W. Gidley.

it belongs to the fourth premolar position. The difference in slope is well illustrated by figure 4. Figure 4*a* shows a third premolar with an angle of slope of 76°, while the 87° angle shown in figure 4*b* is characteristic of the fourth premolar position. The differences can usually be recognized without the use of a goniometer. A graphical representation of the frequency of occurrence of specific angles of slope is shown in figure 5. The angles have been plotted on the abscissae and the percentages of teeth possessing a given angle are recorded on the ordinates. The presence of two well defined maxima on this curve demonstrates the practicability of this method of distinguishing P^3 from P^4.

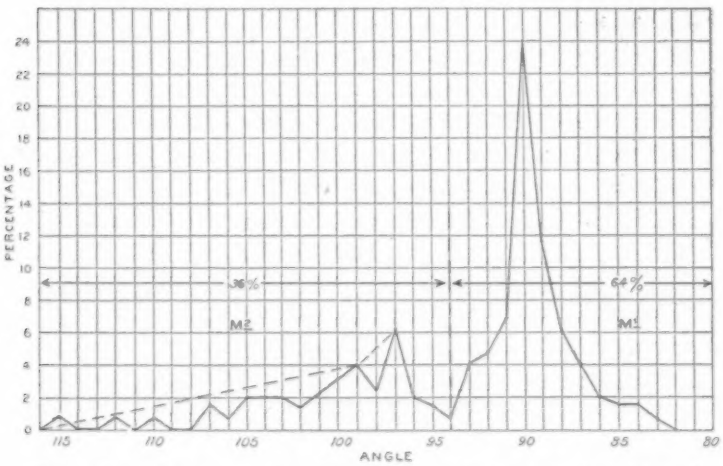

FIG. 8. Graphic representation of the frequency of occurrence of specific angles of slope in M^1 and M^2.

M^1 and M^2, though readily distinguished by their slenderness of parastyle from the premolars (figure 6), are sometimes difficult to set apart. Two characters, namely the anteroposterior-transverse ratio and the angle of slope of the occlusal surface are frequently diagnostic. The ratio of the anteroposterior and transverse diameters is not always a satisfactory character because this ratio approaches the same value for all molar teeth after more than one-half of the height of the crown has been removed by wear. However, if not more than one-third of the crown has been worn away this ratio may be used to advantage.

Figure 7 is a graphic representation of the frequency of occurrence of specific values of the anteroposterior-transverse ratio in M^1 and M^2.

In plotting a curve, figure 8, showing the frequency of occurrence of specific angles of slope in M^1 and M^2 two maxima were obtained. According to the measurements the teeth fall into two groups, one of which (64 per cent) is distinctly larger than the other (36 per cent). Apparently some second molars have an angle of slope which approximates 90°. When, however, the angle between the plane of the occlusal surface and the vertical axis deviates in individual teeth from a right angle it is usually greater than 95°.

FIG. 9. Occlusal view of M^1 (fig. 9*a*) and M^2 (fig. 9*b*) of *Merychippus californicus* Merriam showing difference in anteroposterior diameters when compared to transverse diameters.

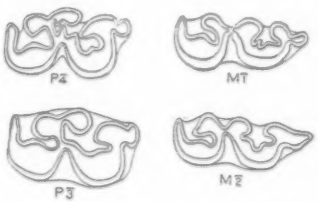

FIG. 10. Occlusal view of P_2, P_4, M_1, and M_2 of *Merychippus californicus* Merriam showing anteroposterior compression of enamel pattern in premolars, and characteristic posterior projection of entostylid in molars.

In M^1 the anteroposterior and transverse diameters of the occlusal surface, figure 9*a*, are subequal and the diametral ratio has a value of 1.05 or less. The angle of slope of the occlusal surface approaches 90°. An angle of slope of less than 90° (89° to 85°) is always indicative of the first molar position. The occurrence of an angle of 90° is much more frequent in M^1 than in M^2.

The occlusal surface of M^2 tends to be elongate in an anteroposterior direction (fig. 9*b*). The anteroposterior-transverse ratio has a value of 1.15 or greater. A value of 1.20 or more is probably always indicative

of the second molar position. If a tooth belonging to the first or second molar position possesses an angle of slope greater than 95° it can be definitely ascribed to M^2.

A molar tooth more than one-third worn, with an anteroposterior-transverse ratio less than 1.15, and an angle of slope between 90° and 95°, can not be definitely placed in the series.

INFERIOR CHEEK-TEETH

As in the superior cheek-tooth series, P_2 and M_3 can be readily identified. The great enlargement of the parastylid and the pointed anterior

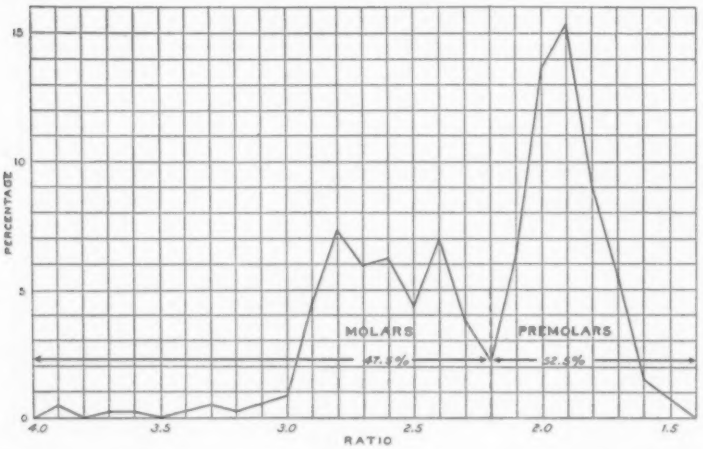

FIG. 11. Graphic representation of the frequency of occurrence of specific values of the anteroposterior-transverse ratio in inferior premolars and molars.

wall of the crown as viewed in cross-section are characters peculiar to P_2 alone. In M_3 the extreme backward curvature of the vertical axis from the plane of the occlusal surface, the presence of an entostylid column with anteroposterior diameter approximately equal to that of the protoconid or hypoconid, and the absence of a surface of attrition caused by wear of a more posterior tooth, distinguish this molar from all other teeth in the inferior dentition.

In merychippine forms the inferior premolars are distinguished from the molars by their more massive appearance (fig. 10). Moreover, the

enamel pattern of a premolar tooth exhibits a compression in an anteroposterior direction. The entostylid in premolar teeth is flattened against the posterior side of the entoconid and never shows the extreme pos-

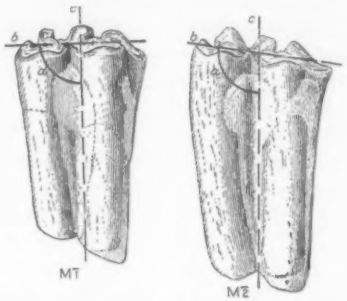

FIG. 12. Lateral view of inferior molars in *Merychippus californicus* Merriam showing differences in the angle of slope (a) in M_1 and M_2, vertical axis (c), and plane of the occlusal surface (b).

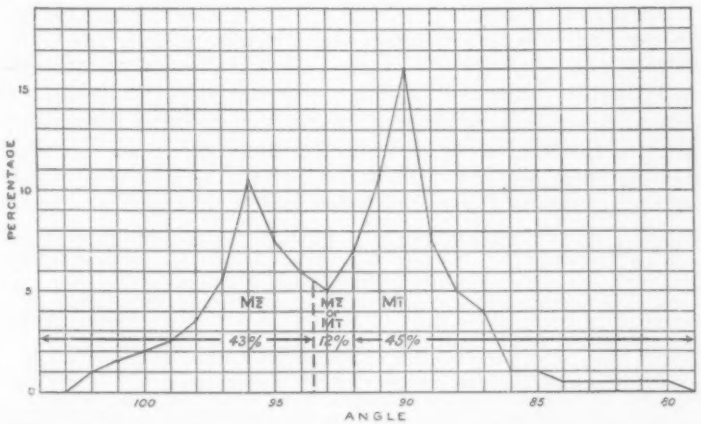

FIG. 13. Graphic representation of the frequency of occurrence of specific angles of slope in M_1 and M_2.

terior projection seen in the molars (fig. 10). The significance of this compression in distinguishing premolars from molars is graphically expressed when the anteroposterior-transverse ratio is plotted (fig. 11).

The premolars have an anteroposterior-transverse ratio that varies between the limits 2.1 and approximately 1.5, while in the molars this ratio ranges from 2.3 to approximately 4.0. While a value of 2.3 or more is always indicative of a molar tooth, the ratio in molars varies with the degree of wear of the crown. A first or second molar that has had more than two-thirds of its crown removed by wear frequently has an anteroposterior-transverse ratio less than 2.1, and is therefore difficult to distinguish from a worn premolar.

In the entire collection of merychippine teeth from the Coalinga locality the greatest difficulty is experienced in attempting to distinguish P_3 from P_4. The occurrence of angles of slope of less than 90° is probably more frequent in third premolars than in fourth premolars, but not to the extent needed in furnishing a definite clue as to identity. It is doubtful whether the characters which have been employed in establishing the identity of individual teeth are applicable to the third and fourth premolars. In this connection it should be noted that the great similarity which fortunately prevails between these teeth lessens somewhat the necessity of discriminating between the two positions.

The angle of slope of the occlusal surface serves to identify M_1 and M_2 (fig. 12). The curve showing the percentage of occurrence of the different angles in these teeth, figure 13, has two distinct maxima, one at 90° and the other at 96°. If the occlusal surface has an angle of slope of 91° or less the tooth may be assigned to the first molar position. Likewise an angle of slope of 95° or greater is indicative of the second molar position. A tooth in which the angle has a value lying between 94° and 91° can not be definitely determined as to position.

Summary of characters useful in determining the position of individual teeth

Superior cheek-teeth

TOOTH	PARASTYLE	ANGLE OF SLOPE	ANTEROPOSTERIOR-TRANSVERSE RATIO
P2	Parastyle greatly enlarged Crown wedge-shaped with apex anterior		
P3	Broad	82° or less	
P4	Broad	85° to 92°	
M1	Slender	85° to 91°	1.05 or less
M2	Slender	94° or greater	1.15 or greater
M3	Crown with extreme backward curvature Posterior wall of crown deeply indented Absence of surface of attrition on posterior wall		

Inferior cheek-teeth

TOOTH	ANGLE OF SLOPE	ANTEROPOSTERIOR-TRANSVERSE RATIO	ENTOSTYLID
P2	Parastylid greatly enlarged Crown wedge-shaped with apex anterior		
P3	93° or less	Less than 2.1	Compressed
P4	85° or 93°	Less than 2.1	Compressed
M1	91° or less	Greater than 2.3	Posterior projection marked
M2	94° or greater	Greater than 2.3	Posterior projection marked
M3	Entostylid column as large as protoconid and hypoconid Crown with extreme backward curvature Absence of surface of attrition on posterior wall		

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THE BREEDING SEASON IN MONKEYS, WITH SPECIAL REFERENCE TO PITHECUS (MACACUS) RHESUS

By Carl G. Hartman

The intensive study of the sexual cycle in the rhesus females of the Carnegie Colony soon gave the very definite impression that the summer months constitute the non-breeding season, when the ovulatory function is at a low ebb and the menstrual cycle as well as the behavior of the sexes to each other show more aberrant phenomena than during the more favorable, the colder, months of the year. The impression has become a certainty. It is the purpose of the present paper to present the evidence along several lines, all of which point in the same direction.

THE IMPRESSIONS OF TRAVELERS

The general testimony in the literature is to the effect that monkeys do not have a breeding season. This is based upon the casual observation of travelers and hunters who enter a country or province during a season favorable to their purposes and, seeing young of various ages, conclude that a given species of monkey breeds all the year round. I find this statement in books, I have it in my correspondence, it is communicated to me personally. Even Sányál, the efficient director of the Calcutta Zoological Garden, was misled in this way (cf. Heape;

1896). This sort of evidence is, however, unacceptable, even though almost unanimous, because it is not based upon carefully recorded facts.

It will be seen below that for the rhesus monkey and for the hamadryas baboon we have sufficient data to establish a breeding season; the data secured in our own colony are alone sufficient for rhesus. Yet if we make a cross-section of this colony on a given day, let us say May 15, 1930, we may be able to duplicate what is seen in a chattering tribe in the forest. Let us then imagine that our colony is a monkey tribe bagged entire by some Münchausen and brought into the laboratory for examination on May 15, 1930.

The list on this day includes a dozen or so of the inevitable poor breeders, either entirely sterile or breeding seldom. Among these are four that had babies the year before. Most of the dozen are menstruating. A second dozen have babies, mostly yearlings of the previous season, ranging in age from 7 to 12 months. Two of the mothers are still interested in their babies and would be suckling them if allowed to do so. Several older babies up to 2 or 3 years old would remain close to their mothers along with the younger brood except for the wire netting enclosing them. The other cases are individually described as follows:

No. 5. Pregnant, 19 days before term.
No. 7. Pregnant, 1½ months before term.
No. 12. Pregnant, 12 days before term.
No. 34. Non-pregnant but about to ovulate and conceive.
No. 35. One month pregnant (about 7 mm. embryo).
No. 39. Fertilized egg in oviduct.
No. 51. Ripe graafian follicle 4 days before actual ovulation and conception.
No. 53. Baby 9 days old.
No. 65. Pregnant, day before parturition.
No. 66. Baby 3 days old.
No. 67. Pregnant, one month before term.
No. 69. Fourteen days post-partum (still birth).
No. 71. Four and one-half months post-partum (baby died).
No. 78. Killed in experiment, would otherwise have had 7 days old baby.

If one thus finds large and small babies following their mothers about, though more or less independent; large and small sucklings; eggs, embryos and large fetuses in utero, not to speak of non-pregnant; and non-lactating females at the same time—one may readily get the impression that the breeding is continuous throughout the year. An overestimate of the length of gestation, still stated in books to be seven months instead of five and one-half as we determined, would tend to increase the illusion. It is of course true that the wide range of stages

found at any given time argues for an extended season during which conception is possible; but it requires a more careful record to determine whether there is also a more restricted *optimum* season for conception.

It follows from the foregoing that the cross-section of our colony on May 15, 1930, as detailed above, should be compared with records taken during a very limited sojourn in the habitat of any given species before the conclusion is reached that breeding in the species is continuous. In this census of May 15 the new acquisitions of a month preceding, now to be described, are not included.

AN INTERESTING SHIPMENT OF RHESUS FEMALES

On April 12, 1930, the Carnegie Colony was enriched by a shipment direct from India of 27 females accompanied by 27 babies, all but two of which were "yearlings" weighing 1060 to 1750 grams. "Mothers with babies" was specified in our order, which was filled perfectly except for four adolescent females that had, of course, never borne young. An analysis of this group of females is of the greatest theoretical interest, not only from the general physiological standpoint, but for comparison of conditions in the wild with those in captivity, for it should be noted that these monkeys were all caught about four months before they were received by us—a diagnosis made by us upon examination of the material and subsequently checked by consultation with the dealer.

Of the 23 adult females shown in Table 1, twelve, or half of them, were accompanied by babies which they claimed as their own and were nursing on arrival; 11 females failed to claim any of the 15 orphans of the group, although 5 gave evidence of recent lactation. The first 6 females in the list gave birth to babies in the laboratory; the next 6 gave birth to or aborted so recently that by rectal palpation the day of delivery (Nos. 100 and 124) or abortion (Nos. 125, 109, 118, 115) could be fixed with great accuracy (Hartman, 1930). Of these 12 four were suckling their large babies and three had very recently given suck; of the entire number only 5 possessed involuted mammae. Nevertheless, it is of interest to note that half of the mature females of the group had become pregnant in the forest the preceding October or November and that most if not all were still suckling babies of the previous spring. The remaining eleven females, all but one of which were lactating *en route* or after their arrival, were thoroughly amenorrheic, with hyperinvoluted genitalia. Presumably they were exposed to the same opportunities for conception in the forest but had delayed ovulation in contrast to their more prolific sisters that conceived in the earlier portion

of the breeding season. It seems probable that in the more favorable natural habitat lactating females come out from under the inhibiting influence of lactation sooner than in captivity—but that is another problem.

This group of 23 mature rhesus mothers, therefore, points very neatly to October and November as near the height of the breeding season of the Bengal rhesus macaque, *Macacus rhesus*, in a state of nature.

TABLE 1

ACCESSION NUMBER	WEIGHT OF SUCKLING BABY	EVIDENCE OF RECENT SUCKLING	PREGNANT ON ARRIVAL (DELIVERED)	ABORTION OR DELIVERY EN ROUTE	AMENORRHEIC	ESTIMATED DAY OF CONCEPTION (1929)
	grams					
98	1,410		April 14			October 31
99	1,560		April 26			November 12
108	1,750		April 29			November 15
114			May 13			November 29
116			May 5			November 21
117		X	May 8			November 24
100				430 g.		October 11
124				480 g.		November 24
125	1,760			X		November 11 (?)
109		X		X		September 28 (?)
118				X		October 27 (?)
115		X		X		October 28 (?)
101	1,310				X	
102	1,390				X	
103	1,480				X	
104	1,060				X	
105	1,160				X	
106	1,310				X	
107	1,490				X	
123	1,550				X	
110		X			X	
111		X			X	
119					X	

The observations just detailed are, however, merely corroborative of Heape (1894, 1896) who in 1891 went to Calcutta to study menstruation and the embryology of the monkey as near as possible to their native haunts. The reason for his going in person to India, he stated, was because of difficulties in securing material from a distance. Thus a shipment of 40 rhesus females secured from Calcutta and shipped to him all proved to be immature—as are, we may add parenthetically,

almost all of the specimens shipped into this country, even those sold by dealers as "mature." Heape was further told that "adult *M. rhesus* are so savage it was found impossible to send them so long a journey without providing a separate cage for each." On his arrival at Calcutta Heape also found that only young monkeys were obtainable in the bazaars. But in due course of time he secured 108 langurs (*Semnopithecus entellus*) and 230 rhesus monkeys. All the collecting was done in January, February and March. Of *S. entellus*, a considerable proportion had already borne young, six of them recently, one was in process of aborting, the rest were non-breeding, 50 of them menstruating. Of the 200 rhesus from Muttra and 30 from Benares "a very large proportion either had embryos in an advanced stage of development in utero, or had recently borne young; of the remainder many had not yet reached the age of puberty, and when all doubtful cases were excluded, 17 specimens alone remained which could be used for the purpose of investigating the phenomena of menstruation." Heape's conclusions as to the breeding season he summarizes in the following words:

"The fact that a very large proportion of the adult females supplied to me during January, February, and March bore advanced embryos in utero, and further, the fact that of those supplied in March a very large proportion had already borne young, points to the conclusion that March is the usual month when most of the young are born at Muttra."

Since we have determined the period of gestation to be on the average 165 days, the best mating season at Muttra should be in September and October, especially the latter month. We are, therefore, in substantial agreement with Heape on the basis of our own lot of monkeys shipped from the field and remaining four months in transit.

OBSERVATIONS OF VAN HERWERDEN ON "CERCOCEBUS CYNOMOLGUS"

In 1905 Dr. Maria A. van Herwerden published a study on the menstrual cycle of *Cercocebus* (*Macacus*) *cynomolgus* (see Addendum for synonym). The material was collected, for the most part, by Hubrecht or by Dutch surgeons on the Island of Banka and on Java, south of Batavia. The material has the advantage of having been killed and fixed in the field, hence represents the normal picture of the species so far as one may unravel it from fixed anatomical material. In this task the author succeeded, for her analysis of the 18 menstruating and 42 intermenstrual uteri of the Javan macaque is a model of this type of study.

Dr. van Herwerden was able to separate the uteri into two classes: A, those with narrow mucosa, interval type of glands, poorly-developed arterioles; and B, those in which the mucosa showed considerable swelling, cork-screw shaped glands, mostly in a secreting stage, thick walled arterioles, especially in the region of the future implantation sites. Now with the latter specimens were associated large graafian follicles or corpora lutea; while the former were accompanied by "empty" or inactive ovaries correlated with the inactive uteri. This is very interesting from a physiological standpoint; but what interests us here especially is the fact that the majority of the inactive uteri were taken during the non-breeding season (May, June, and July) while the class B uteri were removed from animals captured August to January. Furthermore, of 22 pregnancies, conception occurred 20 times in August to October; twice November to January. Perhaps if the period of gestation had been taken at 5½ instead of 7 months, the range would have fallen slightly later, hence almost exactly coincident with our own experience in the Carnegie Colony.

It is thus apparent that the Java macaque has a breeding season comparable with the closely related rhesus monkey.

OBSERVATIONS ON THE CARNEGIE COLONY OF RHESUS MONKEYS

At the time of this writing the protocols of the monkeys that are now or have been members of the Carnegie Colony at Baltimore contain records of 38 conceptions; of these 25 reached term and 4 pregnancies are still in progress. If we include animals pregnant on arrival we have records of 36 births, of which 10 were witnessed by us. The data on conceptions are accurate almost to the day (except 78 and 92, which are close estimates) and the large number of cases make them of special value.

If now we plot the conceptions by weeks and months (line 1, chart 1) we find that 14 fall in November, 28 in the period October to January. September has one, the quarter of June, July and August the single one that "proves the rule." This is our No. 2, an unusually fine breeder that arrived with a baby, delivered two since (cf. Hartman, 1928), and conceived again July 29 last. She is the only animal of the colony that even approached ovulation during this season.

The result of this monthly distribution of conception would seem to leave little room for doubt. It might be objected, however, that the animals have less opportunity for copulation than in the late fall or early winter. This is in part true; but the percentage of "takes" still

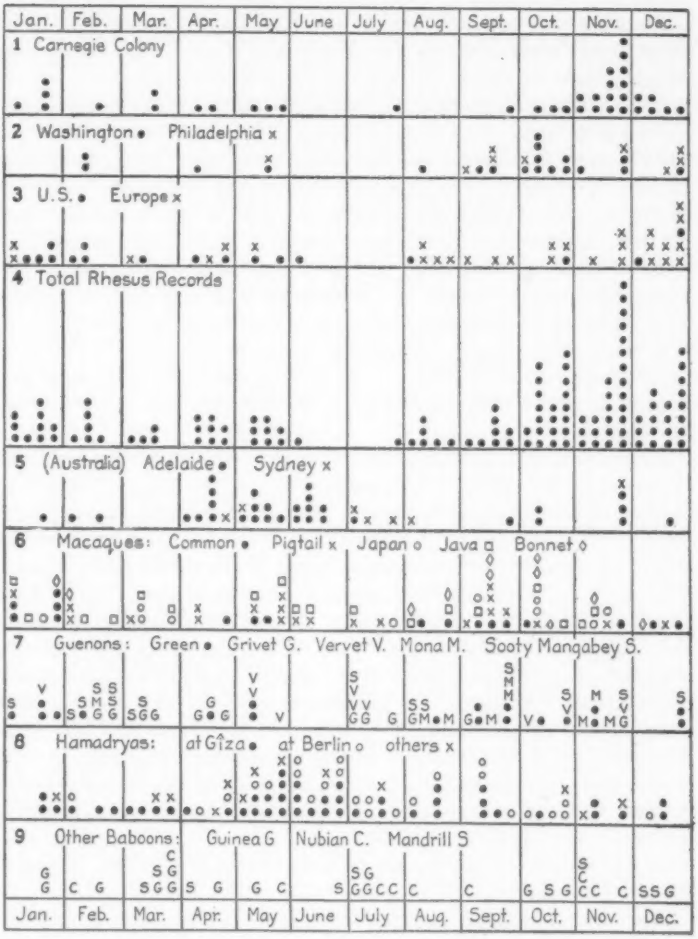

CHART 1. CONCEPTION DATES FOR MONKEYS, CALCULATED FROM BIRTH DATES
Lines 1 to 5 refer to the rhesus monkey *Pithecus* (*Macacus*) *rhesus*

leaves the distribution essentially correct and the conclusion that the summer months are unfavorable for reproduction is shown in more direct observations upon the females at this time. Three kinds of observation may be cited.

In the first place, the heat of summer is unfavorable to the monkey, at least *to the tropical monkey*. This is well known to animal importers and hunters. We find it so in the Carnegie Colony. By far the greater number of deaths have occurred in the summer and fall months even among the "acclimated" individuals, though the death rate has been cut down since we have ameliorated the heat conditions by using a fine spray of water or "artificial mist" in the paddocks. The animals are more likely to lose weight in the summer, and they then shed their hair, which further exaggerates their unprepossessing appearance at this time. Menstruation is more irregular in summer, often absent entirely; moreover the sexes are far less interested in each other and the usually quite willing males may occasionally even entirely refuse to copulate.

An examination of the females, however, corroborates the suspicion that they do not conceive because they do not ovulate. This is clear from an inspection of table 2, which gives the result of 60 laparotomies done at various times of the year. The dates falling in the breeding season are placed in columns, those falling in the summer in column 2. The sign "+" indicates the finding of a corpus luteum, "±" a large Graafian follicle, "−" neither corpus luteum nor follicle. The latter class comprises 13 laparotomies done in June and July and with one exception (No. 66) the ovaries were "empty," rarely showing a visible follicle, never over one or two millimeters in diameter. Most of these females were menstruating nevertheless. No. 66 was exceptional in possessing a Graafian follicle, 5 x 6 mm. in diameter, on July 14, 1929; on January 15, at the end of a pathological bleeding of over a month the ovaries contained numerous small follicles. This partly explains the apparent reversal of the usual findings of the table. This animal subsequently became pregnant, giving birth on May 12, 1930. She died the following September.

The negative cases of column 1 further show the absence of ovulation in certain menstrual cycles even in the more favorable months; actually the proportion of such cases is much greater, since the table registers the more favorable females in the more favorable times of the year. It is perhaps unnecessary to add that in correlation with the apparently inactive ovaries the uteri were also found to be very small and pale, in

TABLE 2

Laparatomies and biopsies

+ = corpora lutea; ± = large Graafian follicle; * pregnant later; − = "resting" ovaries.

NUMBER	BREEDING SEASON	NON-BREEDING SEASON	NUMBER	BREEDING SEASON	NON-BREEDING SEASON
*4	November 2+ January 17 + November 22 +	July 30 −	42	November 5 ± April 3 − November 13 ±	July 29 −
3	November 2 + January 19 +		*43	October 4 + November 8 +	
17	November 22 + December 12 +		46	October 26 +	
20	November 8 ±	July 30 −	53	September 3 −	
22	———	June 4 −	56	March 6 −	
28	January 23 ± November 8 + November 24 +	June 21 −	57	January 18 ± November 7 +	June 20 −
*32	January 22 +		63	February 5 + February 27 + March 19 + November 15 +	July 15 −
*35	November 4 − January 17 +		64	———	July 30 −
38	January 31 +		*65	January 23 + February 15 +	
39	March 14 − October 3 − December 4 +		*66	January 15 −	July 30 ±
*40	November 8 + December 4 + November 3 +	June 7 −	*67	January 21 −	July 6
			*69	November 21 +	
*41	January 8 + October 5 ±	July 29 −	*70	January 10 −	July 18 −
			*71	November 19 ± December 6 ± November 7 +	

most cases almost infantile. It is thus seen from actual inspection of the genital organs that no matter how often the females had been mated they could not have conceived because of the complete absence of ovulation.

The case is greatly strengthened by rectal palpation of the uterus and ovaries in the living animal, i.e., by the rectal bi-manual method of palpation well known to the gynecologist. The uterus can be felt with the greatest ease and its size and consistency accurately estimated; the ovaries are a little more difficult to find in some, especially the larger females. Applying this method to the females of the colony July 22, August 24 and September 30, 1930, we recorded the following findings:

July 22: Of 28 adult females examined all but three had tiny uteri, mostly about the size of a lead pencil, and ovaries of corresponding inactivity. The three exceptions were: No. 28, uterus the size of the rubber bulb of an eye-dropper pipette, right ovary small, left medium; day 21 of cycle. No. 40, uterus medium to large, firm; right ovary small, left medium; day 25 of cycle. Neither of these two females had ovulated and there was no pregravid enlargement of the uterus. The third animal (No. 2) is remarkable in furnishing us our only example of conception in the summer months. On the day under consideration, which was the eighth of the cycle, the left ovary was already of medium to large size, the uterus distinctly enlarged (medium to large), though still firm. She was caged three successive days with three different males but failed to copulate with the first and probably also with the third; conception is estimated to have taken place on July 24, day 10 of the cycle.

On *August 24* the palpation was repeated. On this day 16 uteri were "tiny," 7 small, 5 medium, none large. The animals were molting and the bright color of the buttocks was conspicuous by its absence. The experienced observer could see at a glance that most of the animals were far below the sexual condition obtaining in the better seasons of the year.

By *September 30* the improvement was already very apparent, for most of the animals (all but 7) showed fairly good color, half of them were quite bright, 6 or 8 of the maximum brilliance. Five uteri were large, 10 medium, 4 small and 7 tiny. The retarded females were exclusively members of the shipment of April 12 not yet recovered from the journey. One or two of these will probably never recover.

The low ebb of sexual activity in the Carnegie Colony in the summer months is therefore incontrovertible and the sterility of the animals is

due to the absence of an ovulatory cycle, although menstruation continues. That the males are not sterile is shown by the repeated recovery of motile sperms from mated females and by a single conception on July 24 in a favorable female. Yet the males are less ardent in summer than in winter and refuse mating with some females altogether.

To summarize our observations in the Carnegie Colony: Only one conception out of 38 occurred in the summer months, over half in October, November and December. Ovulation in summer is almost as rare as conception, as determined by laparotomies and by the newly instituted rectal bi-manual palpation.

EXPERIENCE AT ZOOLOGICAL GARDENS OF THE WORLD

If *Macacus rhesus* has a non-breeding season at Baltimore, it should also have one in other parts of the world where the species is kept in confinement. Accordingly, the directors of the larger zoological parks of the world were requested to send a list of the dates of the births occurring in their private colonies. Twenty-three responded and were kind enough to send their data, for which many thanks are due.

The results of the questionnaire are shown in graphic form in Chart I, which almost speaks for itself. The chart shows conception dates calculated 165 days back from the birth dates. Line 1, showing the distribution of conception dates in the Carnegie Colony, has already been discussed. Line 2 shows the cases reported from the Washington and the Philadelphia zoos. Comparing these two lines, it appears that the animals of our colony are a month behind the others, perhaps because our animals are mated only on specific days, hence miss the first chance of the season for conception. It is possible that, after all, October is the optimum month for conception and not November. Line 3 gives the remainder of the data available from over the world; line 4 the combination of all cases we have been able to find. The latter clearly shows that October to January are clearly the fertile months; June, July and August clearly the low ebb for breeding of the rhesus monkey—all of which holds, however, only for the northern hemisphere; for the fine lists from Adelaide and Sydney, Australia, as plotted in line 5, render the assumption plausible that April to July instead of October to January constitute the optimum breeding season in the southern hemisphere.

With respect to other macaques (line 6) we can only say that there is a slight tendency towards the September to January season. For the tropical guenons and the mangabeys we have insufficient data,

which holds also for the various baboons (line 9). But the hamadryas baboon of Abyssinia, both in Berlin as well as in Gîza, Egypt, near its native haunts, seems to have an optimum breeding season in May, June and July; December, January and February being the low months. The conception day for baboons was calculated by counting back 169 days from the birth data (Zuckerman and Parks, 1930).

The seasonal variation in conception rate is therefore in no species so clear as in rhesus; but we have no data for any other species nearly so complete. The nearest approach is that for hamadryas.

NEW WORLD MONKEYS

Rather extensive observations were made on *Alouatta caraya* and *Cebus azarae* in Paraguay by Dr. Rengger about a hundred years ago. Interned for some years by the Paraguayan government, he devoted himself to the study of South American mammals. He states that *Alouatta* has its young in June and July, only occasionally in May and August, while *Cebus* has a single young in December.

Wislocki and Schultz (Wislocki, 1930) collected monkeys in Panama and Nicaragua during July and August of three different years. On the basis of their findings they concluded that of the six species collected, one (*Saimiri oerstedii*) had a limited breeding season, whereas the three other species (*Ateles geoffroyi, Cebus capucina, Alouatta palliata*) taken in considerable numbers show continuous breeding throughout the year.

SUMMARY

That macaques experience seasonal variations in the conception rate amounting to an almost complete cessation of ovulation during a part of the year, which we may call the non-breeding season, seemed almost certain from the observation of Heape (1894, 1896) in (Pithecus) *Macacus rhesus*, and of van Herwerden (1905, 1906) on local forms of the *M. irus* group. Both placed the optimum season in October. Practically the same holds for the Carnegie Colony (38 conceptions) and for the various zoological gardens of the world (Chart 1), but is rather reversed in Australia, where April to June instead of September to January constitute the favorable season. The data for other Old World monkeys are too few to warrant conclusions, although the principle seems to hold for macaques in general. The hamadryas baboon seems to have its best season from May to July.

In addition to this sort of evidence it was found at the Carnegie Colony that failure of the females to conceive was due to their failure

to ovulate, not due to sterility of the male, although he is somewhat adversely affected in his reactions to the female. This conclusion was derived from 60 laparotomies performed at various times of the year and by rectal palpation of the uterus and the ovaries. The non-breeding season is also the molting period. It is of theoretical and gynecological interest that menstruation may go on regularly throughout the entire summer in the absence of ovulation.

KEY TO THE COMMON NAMES USED ABOVE

Specific names after Elliott

Rhesus: *Pithecus rhesus* (*Macacus rhesus*).
Common: *P. irus* (*Macacus cynomolgus*).
Pigtail: *P. nemestrinus*.
Japanese: *P. fuscatus*.
Javan: *P. mordax* (*P. fascicularis mordax?*).
Sumatran: *P. fascicularis*. (The Banka, Sumatra, and Java forms are closely related and are classed as subspecies of *P. fascicularis* by some. Van Herwerden, therefore, working with material collected both in Banka and Java, used specimens of two different subspecies or species. But for practical physiological and anatomical purposes the slight racial differences are relatively unimportant.)
Bonnet: *P. sinicus* (*M. radiata*).
Sooty Mangabey: *Cercocebus aethiops*.
Green: *Lasiopyga callitrichus* (*Cercopithecus aethiops*) *Simia sabaeus*.
Vervet: *L. pygerythra*.
Grivet: *L. griseoviridis* (*Cercopithecus aethiops*).
Mona: *L. mona* (*C. mona*).
Hamadryas: *Papio hamadryas*.
Nubian baboon: *P. cynocephalus*.
Guinea baboon: *P. papio*.
Barbary ape: *Simia sylvanus* (*Inuus ecaudatus*).

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NOTES ON THE FEMALE REPRODUCTIVE TRACT (OVARIES, UTERUS AND PLACENTA) OF THE COLLARED PECCARY (PECARI ANGULATUS BANGSI GOLDMAN)

By G. B. Wislocki

[*Plates 3–4*]

Practically all that is known concerning the female reproductive tract in the Suidae is based upon observations on the domestic sow. In this animal both the anatomy and physiology of reproduction have been carefully studied. Nothing is known on the other hand about the wild forms, excepting the comparison by Käppeli ('08) of a number of ovaries of the wild European swine with those of the domestic sow. He observed that the ovaries of wild swine are relatively smaller and contain on an average fewer visible follicles and corpora lutea than those of the domestic forms. The wild pigs, according to Käppeli, produce, on an average, four young, the domestic ones, 8 to 12 young. Moreover, the European wild form, Käppeli states, is monoestrous, whereas the domestic sow is polyoestrous, the single oestrous period occurring in the former during November, with birth of the young in February and March. The European wild sows possess 8 to 10 mammae and produce from three to eight young, with an average of four.

The writer had an opportunity to obtain a gravid uterus of the collared peccary and was surprised on examining it to discover that it differs materially from that of the sow with which he was already familiar. The differences in the two forms are deemed worthy of brief description. The domestic pigs originate from wild stocks of the Old World, having all been introduced into the western hemisphere. The peccaries, on the other hand, are wild forms indigenous to the New World only and are distantly related to the Old World families. It might be predicted, therefore, that they would differ from the domestic sow even more than the European wild form observed by Käppeli.

The specimen to be described is of a collared peccary (*Pecari angulatus bangsi* Goldman) belonging to the family Tayassuidae. The present species inhabits the eastern section of Panama. The specimen was obtained from an animal killed during the month of July on Barro Colorado Island, Panama Canal Zone.[1]

[1] This material was obtained while the writer was working at the Barro Colorado Island Laboratory, Canal Zone. I am indebted to Dr. Robert K. Enders, who had permission to collect mammals on the island, for turning the specimen over to me.

GROSS OBSERVATIONS

The uterus is bicornuate as in the sow. The cornua differ, however, from those seen in the sow in that they are relatively short and are coiled, with each horn forming a helix or spiral. This configuration alters the shape of the broad ligament, which becomes a spiral band with broad fan-shaped insertion on the uterine cornu and a converging, pedicle-like attachment to the pelvic wall. The ovaries are situated relatively caudad in the body cavity, on the margin of these pedicles at the level of the junction of the two cornua. The Fallopian tubes are much shorter than in the sow and more coiled. The superior and inferior mesosalpingeal ligaments are short and stout compared to their delicate membranous character in the sow. The fimbriae are much less extensive and delicate than in the sow, forming a well-defined elliptical orifice bounded by two well-formed leaflets. The ellipsoidal orifice terminates in an ovarian fimbria attached to the ovary and in a uterine fimbria attached to the superior mesosalpinx. The ovaries are relatively large. Because of the shortness of tubes and mesosalpinx the ovaries do not become encapsulated by the tube and its appendages as they do in the sow. A small, deep recess is formed, however, between the superior and inferior mesosalpinx. This, the ovarian bursa, is too small actually to enclose the ovary, excepting possibly one pole.

The ovaries are symmetrical in shape. Each is composed of two fused nodules of about equal size. The ovary is attached to the broad ligament by a stout, fibrous ligament which attaches to one of the spherical masses, the other spherule constituting the free pole of the ovary. On cutting open the ovaries they are found to be identical in configuration. At the free pole each exhibits an orange-colored nodule measuring 10 mm. in diameter. The nodule of nearly equal size at the attached pole is reddish in appearance. On section each of these spherical masses is found to be a corpus luteum, so that the ovaries together contain four corpora lutea. However, the yellowish corpora are of one stage, the reddish corpora of another stage of development. We are probably dealing, therefore, with corpora of two different ovulations, the two yellowish ones being the more recent and appertaining to the two fetuses in utero. The reasons for this decision will be presented later, together with a description of the microscopic appearances of the ovaries. The ovaries of the peccary are distinctly unlike those of the sow in exhibiting two sets of nearly equal-sized corpora at a time when relatively large fetuses are in utero. The facts that the uterine cornua are relatively short and that the peccary has but two mammae makes it appear likely that fewer ova are released at ovulation than in either the domestic sow or in the European wild swine.

Each uterine cornu contains a fetus and its membranes. The fetuses are each approximately 48 mm. in crown-rump dimension. In general appearance the fetuses and their membranes resemble pig fetuses and their adnexa of equivalent age. In detail, however, there are pronounced differences between the two.

As in the sow, the chorions are fusiform and are loosely applied to the uterine mucosa from which they can be readily stripped off without damage to either. The ends of the chorionic sacs for a distance of several centimeters are avascular. The avascular tips of the chorionic sac are in part caked together by gummy detritus. In several places this material has formed rubbery masses loosely attached

to the interior of the allantois and, in one instance, such a mass has become completely detached and has come to lie free within the allantoic sac. The withering of the tips of the chorion, as seen in the sow, is not accompanied by the formation of similar nodules.

The chorion is in contact with the endometrium by numerous, minute wrinkles or folds interdigitating with corresponding folds of the mucosa. Removed from the uterus and stretched slightly, the chorion becomes a perfectly smooth membrane without macroscopic elevations. In contrast to the sow of equal age no areolae are macroscopically visible as yet to the naked eye. If, however, the chorionic membrane is viewed under low magnification by means of a Greenough binocular microscope, areolae are seen to be abundantly present (Fig. 1). The surface of the chorion is observed to be covered by short, anastomosing, microscopic ridges. In this pattern there are gaps constituted by the areolae, which form microscopic, circular, shallow depressions devoid of ridges. At the circumference of an areola the aforementioned chorionic ridges assume a radial disposition dipping over the margin into the shallow, smooth crater of the areola. Viewed unstained in this way, after fixation in Bouin's fluid, the chorionic ridges are observed to change in microscopic texture on the circumference of the areola. The ridges in general are opaque, like ground-glass, but, as they radiate towards the areola in the vicinity of its margin, the ridges suddenly become translucent and greyish in character. This appearance indicates a difference in cellular character of the chorion in the two positions. In the bottom of the shallow crater of the areola the microscope reveals irregularly dispersed flocculent shreds of substance.

A small, flaccid, wrinkled yolk-sac, yellowish in color and similar to that seen in the sow, is visible in the extra-embryonic coelome at the end of the umbilical cord. Umbilical cord and amnion are smooth and translucent differing in no wise from those of the sow.

MICROSCOPIC OBSERVATIONS

Microscopically the uterus and placenta of the peccary and the sow are similar, although possessing certain distinguishing features. The endometrium of the peccary's uterus at this stage shows hypertrophied glands imbedded in an oedematous stroma (Fig. 2). The uterine epithelium is entirely intact and the individual cells are cuboidal in shape. They rest upon a delicate basement membrane in which a rich plexus of maternal capillaries can be distinguished. This outermost zone of endometrial stroma, enclosing the capillary vascular layer and forming the basement membrane for the epithelium, is denser and less oedematous than the remaining deeper portions of the stroma. So far conditions are as in the sow, but in the peccary the endometrium is distinctly narrower than that of an equivalent stage in the sow—the outer vascular layer is more delicate and the glandular layer is less broad and the glands in general simpler and less branched.

Microscopically, too, the chorions of the two animals are similar although possessing certain distinguishing features. The chorion in both animals is thrown into minute folds or rugae with furrows between them. Around the areolae the rugae are radially arranged (Fig. 1). In sections the rugae, cut transversely, give the appearance of minute villi.

The chorionic epithelium differs in its morphology upon the crests of the rugae and in the troughs between them (Figs. 3 and 4). On the crests of the rugae the epithelium is flattened and syncytial and is penetrated by capillaries. The penetration of the epithelium by capillaries in the sow is well described and portrayed by Heuser ('27). The most interesting point in the peccary is the presence of syncytium or plasmoditrophoblast on the rugae. In the sow by contrast the summits of the rugae appear to be clothed for the most part by cytotrophoblast. In the furrows between the rugae, the epithelium on the contrary is composed of individual columnar cells the arrangement of which is not dislocated by penetrating capillaries. Thus there are two morphologically and physiologically distinct zones of chorion on the crests of the rugae and between their bases respectively (Figs. 3 and 4). The rugae subserve undoubtedly the more direct interchange of substances between the fetal and maternal circulations, especially the gaseous exchange, whereas the regions of the furrows appear suited for a more indirect mode of absorption of salts and formed substances by more highly organized, columnar absorbing cells. In the peccary one can speak of a highly vascular plasmoditrophoblast on the crests of the rugae subserving more direct transmission and of a relatively avascular cytotrophoblast in the furrows between the rugae constituting an indirect mode of transmission more of the nature of so-called embryotrophic nutrition.

The intimacy of the maternal and fetal circulations on the crests of the rugae is striking. On both maternal and fetal sides intervening connective tissue is almost negligible. Capillaries, stripped bare of all except endothelium, press against the epithelial cells of the endometrium and on the opposite side, similarly, naked capillaries actually tunnel the plasmoditrophoblast leaving only slender, nucleus-free strands of syncytial cytoplasm between them and the outside. Thus the two circulations are surprisingly close to one another at these points. When one considers the number of layers which intervene in the placenta epitheliochorialis according to the concepts of Grosser ('29), one is amazed by the complexity of the theoretical barrier. Actually, however, two of these layers—the fetal and maternal connective tissue—are practically wanting and in addition the association of the two circulations is made more intimate by the penetration of the fetal capillaries into the delicate trophoblast on the crests of the rugae (Figs. 7 and 8).

In the peccary, as has been said, the crests of the rugae are clothed by plasmoditrophoblast, while in the pig this is undoubtedly not the rule. The furrows although analogous in the two forms show distinctive features in the configuration of the lining epithelial cells. In both forms, the epithelial cells are columnar, but in the peccary there are very definite inner and outer zones to the cells with the nuclei in the centers, whereas in the pig of equivalent age the inner zones are not so distinct, the nuclei almost touching the basal surfaces of the cells. In the peccary the basal portion of a cell is set off from the nucleus by an inner zone composed of one or more clear vesicles the walls of which take a basic stain. The outer zone, on the contrary, which is alike in peccary and sow, is rich in solid protoplasm which stains intensely with acid dyes.

Besides the two types of epithelium described on the summits of the rugae and in the furrows between them, there is, as in the pig, a third type of epithelium

which is encountered in the areolae. At the borders of the areolae, the trophoblast, which has been either syncytial or columnar respectively, changes to an epithelium, lining the areolar crater, which is somewhat cuboidal in shape. These cells are rather irregular in contour but are, for the most part, as wide as deep. Their nuclei are slightly eccentrically placed toward the basal portion of the cell. The cytoplasm of these cells is rather clear, both in the distal and proximal halves, differentiating them from the columnar cells which are divided by the nuclei into morphologically distinct inner and outer zones.

MICROSCOPIC STRUCTURE OF THE OVARIES

As has been related in the description of the gross specimen, the ovaries are rather unusual in that each ovary contains two corpora lutea of approximately the same size, yet of different stages of development. On looking over pregnant pig's uteri nothing similar has been encountered. In the pig, at the time of ovulation, the corpora of the previous ovulation are declining and are never more than four millimeters in diameter and furthermore by the end of ten days after fertilization these corpora have invariably receded to the shape of yellowish plaques less than two millimeters in diameter. In the peccary, on the other hand, with fetuses of 48 mm. length in utero we have in each ovary two large corpora lutea of different stages of development. The larger corpus luteum is approximately 10 mm. in diameter, the smaller corpus luteum is fully 7 mm. in diameter.

The larger corpora lutea in all likelihood pertain to the fetuses in utero. The principle reason for believing this is the lesser amount of connective tissue in the larger corpora as seen in Mallory preparations.

The larger corpora differ markedly in their cellular morphology from the smaller ones (Figs. 5 and 6). The larger, and presumably the more recent, corpora are composed of two types of cells which are distinguishable at a glance (Fig. 5). The first is an exceedingly large cell with dense, almost homogeneous cytoplasm, multipolar outline and usually one, sometimes two, small nuclei. The second type of cell is only approximately one quarter as large as the first type. The cytoplasm of this cell is less dense and stains less deeply. These cells are polygonal in shape and have a slightly larger, less densely chromatin-containing nucleus than the first type of cell. Between and surrounding these two types of epithelial cells are slender strands of capillaries and connective tissue.

The smaller corpora lutea are composed, on the contrary, almost solely of a single cell type which resembles most closely the second or small type of cell of the preceding description (Fig. 6). These cells differ from the former, however, in that they are deeply pigmented. Each cell contains, in the cytoplasm to one side of the nucleus, a large accumulation of pigment, bright yellow in eosin-stained sections, almost black in iron haematoxylin. The conspicuous cells of the first type in the preceding corpus luteum are nearly absent, occurring only in a few scattered fields. In the absence of more stages it is difficult to interpret the fate of the large cells, but from the morphology of the few remaining cells of the large type, it appears that in all likelihood they have undergone degeneration, whereas the pigmented cells are derivatives of the small cell of the former stage. As has been said, the smaller corpus luteum is becoming infiltrated by dense strands of connective tissue which stain deeply in Mallory's stain. This circumstance is the

principal evidence for the conclusion that the smaller corpus is the older stage of the two. Moreover it is less well differentiated at its borders from the surrounding stroma of the ovary. Furthermore the large cells of the previous stage appear to be degenerating.

In the absence of a series of stages of corpora lutea it is impossible to trace the origins of the two types of epithelial cells from the granulosa or theca interna. No large follicles are present in the ovaries, the largest being not over two millimeters. In the follicles of this size, granulosa and theca interna are readily distinguishable, but their cellular components cannot be directly homologized with any of the cellular types found in the corpora lutea.

There is no adequate explanation at hand of the persistence of two sets of corpora lutea of different stages this late in pregnancy. It can merely be pointed out that in this respect the peccary differs materially from the domestic pig. The present observations afford additional evidence of the extremely variable morphology of the mammalian ovary. It is interesting that in the sow Corner ('19) was able to discriminate two types of epithelial or lutein cells, tracing one kind from the granulosa, the other from the theca interna. In the present instance, in the absence of a series, the origin of the two types of epithelial or lutein cells cannot be traced. However, one can affirm the presence of two distinct types of lutein cells, possessing markedly different morphology, and analogous in all probability to the two types of cells described by Corner in the domestic sow.

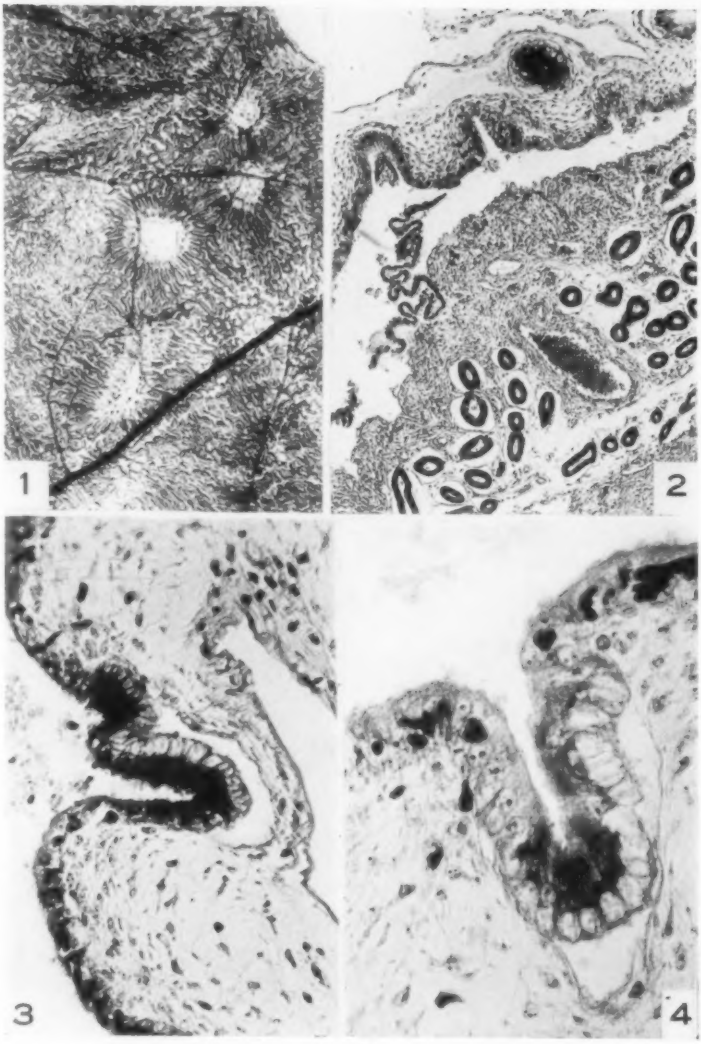
CONCLUSION AND SUMMARY

In contrast to the basic similarities of related forms, there are certain pronounced differences between the reproductive tracts of the domestic sow and the peccary. The peccary has only two mammae and its uterus is small, affording room for a more limited number of young than in either the wild European or domestic sow. The configuration of the uterus, tubes and ovaries of the peccary differs materially from that of the domestic sow.

Placentation is essentially alike in the two forms excepting for minor differences. The most interesting differentiating character is the presence of plasmoditrophoblast on the summits of the chorionic rugae in the peccary. In connection with this observation the question of the differentiation of the chorion for placental transmission is discussed.

The ovaries of pregnancy are of interest in the peccary, because they differ in some respects from those of the domestic pig. At a relatively advanced stage of gestation two sets of large corpora of different degrees of development are present. The one set pertains to the fetuses in utero; the other set pertains to a preceding ovulation. As in the sow, the corpora lutea are composed of two types of epithelial or lutein cells. In morphology, however, these cells differ distinctly from the equivalent cells of the sow.

An interesting result of the comparison of the repoductive tracts of the peccary and pig is the observation that the reproductive tract itself differs in the two forms very much more than the placentae. The writer has found in other instances that the placenta of relatively closely allied forms resemble one another very much more than the respective genital tracts. Amongst the anthropoid apes and man, the placentae can scarcely be distinguished from each other, whereas the repro-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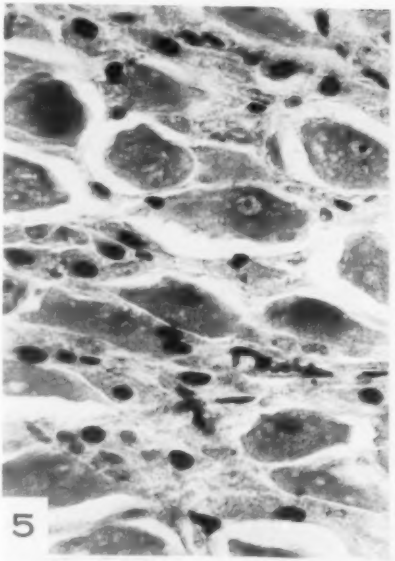

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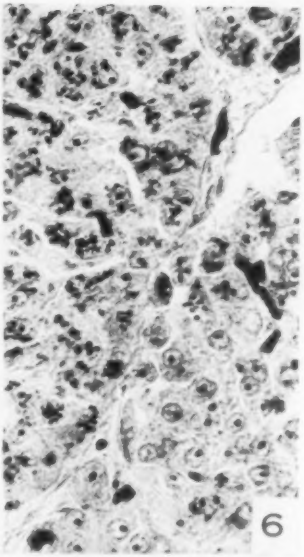

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ductive tracts can be told apart with ease. This is surprising, since in unrelated, or distantly related, groups of animals, on the other hand, placentation is, as a rule, exceedingly diverse. Thus placentation has been given precedence in the past over many other organs in the larger grouping of mammals. On the contrary, however, when dealing with closely related forms the placentae show fewer distinguishing characters than many other tissues and organs, including the reproductive tracts themselves.

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EXPLANATION OF PLATE 3

FIG. 1. View of the chorion of the peccary spread out as a membrane and stained with cochineal, showing several areolae. The minute rugae which cover the chorion can be seen radiating towards the areolae. × 8.

FIG. 2. View of a portion of the chorion and the uterus of the peccary. Most of the uterine epithelium is detached. The uterine glands are surrounded by loose, oedematous connective tissue. × 72.

FIG. 3. View of a portion of the chorion of the peccary, showing the character of the epithelium lining the summits of the chorionic rugae and the folds between them. × 440.

FIG. 4. Another view of the chorionic epithelium, showing the columnar epithelium lining a chorionic trough and the syncytial epithelium on the summits of the folds. The black masses near the surface of the chorion are blood corpuscles within capillaries which penetrate the syncytium. × 440.

EXPLANATION OF PLATE 4

FIG. 5. View of one of the larger and more recent of the corpora lutea in the ovaries. The two types of epithelial cells constituting the corpus luteum can be seen. × 440.

FIG. 6. View of one of the smaller and older corpora lutea, showing only one type of cell which is heavily laden with pigment. × 440.

FIG. 7. View of the chorion of the domestic sow. The fetal vessels have been injected with India ink to show the relative vascularity of the summits of the rugae and the troughs between them. The difference in the character of the epithelium in the two localities can be seen. × 240.

FIG. 8. A similar injection of another area of the chorion of the sow, showing how the vascular plexus, on the summit of a chorionic fold, penetrates the epithelium to come into close proximity to the surface. × 240.

THE FALL MOULT OF MUSTELA LONGICAUDA

By Frederic W. Miller

Having described in a previous paper[1] the spring moult and the change in color from white of winter to brown of summer in a captive specimen of *Mustela longicauda longicauda* Bonaparte, it seems to me desirable to record the succeeding fall moult and consequent color reversal of the same individual.

As was stated in the paper referred to, the specimen on which these observations have been made is an adult male, taken February 26, 1930, in western Adams county, Colorado. During the period of its captivity, it has been maintained in an indoor cage.

With the beginning of autumn, that is, early in September, there was a noticeable lightening in the general tone of the brown summer coat, particularly on the dorsal surface. Close examination showed that this was not caused by shedding, or by the appearance of new hairs, but was due to abrasion and the breaking off of the dark tips of many of the longer hairs.

By October 20, the moult had definitely begun, for just above the black tail pencil there appeared a narrow band of new white winter hairs, and on approximately the same date scattered white hairs made their appearance in the summer yellow on the ventral surface of the neck. In the course of a few days, the entire ventral surface of the animal was spotted with slight concentrations of new hairs. These were most in evidence on the neck and inner surface of the limbs.

A gradual enlargement and merging of these spots took place; many new ones appeared, and this process continued until November 10th, when the moult on the ventral surface was completed. Up to this time, so far as observable, there was no evidence of a definite mode of progression in the moult. Instead, new hairs had appeared simultaneously throughout the area and in similar fashion the old ones had been shed out.

In the meantime, the new coat had evinced itself on all four feet and had gradually worked up onto the legs. The white on the tail had developed from an initial circlet above the pencil into superior and inferior wedges that thrust deeply toward the basal portion. The pencil itself was being shed and replaced by the longer black hairs of the winter pelage.

[1] Miller, Frederic W., Spring Moult of Mustela longicauda. Journal of Mammalogy, Vol. 11, No. 4, pp. 471–473.

From the ventral surface, the moult now worked laterally onto the flanks in a sharply demarked line, and from this date on followed a clear-cut, well-defined program. The new hair in two ascending tongues reached across the neck behind the ears. Similar tongues crossed the sides of the muzzle and terminated in front of the eyes. On top of the nose an additional area of new hair developed so that on November 15 the animal presented a dorsal pattern as represented in Fig. A. By

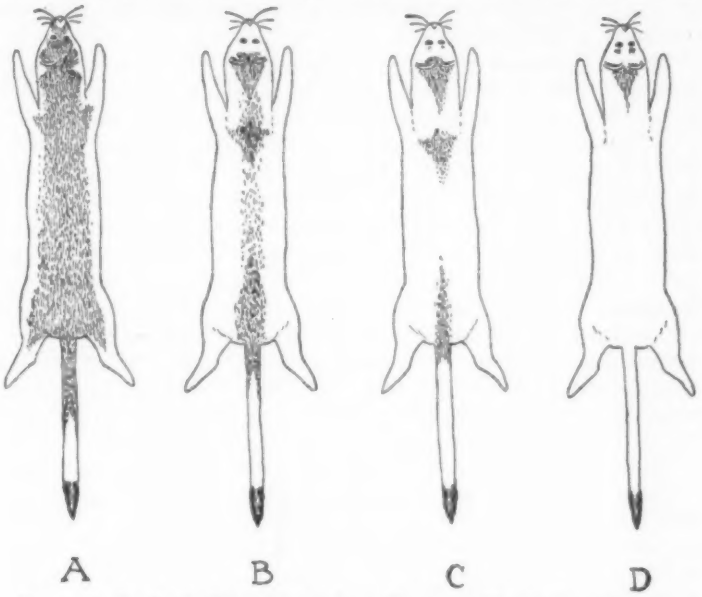

FIG. 1. A, B, C, D. PROGRESS OF FALL MOULT IN MUSTELA LONGICAUDA

lateral progression along the entire front, the moult quickly reduced the remaining area of old hair to a narrow dorsal band and, working backward from the nose and muzzle, soon cleared the face. As the old hair retreated the supra-orbital spots made their appearance and slowly increased in density; though failing to become jet black as in the previous winter's pelage, they remained dusky black.[2]

[2] Dr. E. Raymond Hall, who has critically read these notes, has called my attention to the fact that weasels usually do not possess supraorbital spots as a normal feature of the winter pelage. In the present individual they are persistent and well marked.

By November 24 there was a marked disintegration of the dorsal stripe, which isolated three areas of the old coat, one on the back of the head and nape of the neck, one across the shoulders and one in the pelvic region. See Fig. B. These were entirely isolated by December 1, as shown in Fig. C.

The shoulder and pelvic areas of old hair were complete obliterated by December 8, leaving only a triangular patch on the head and neck as in Fig. D. This area shrank slowly along its entire perimeter and on December 28th was gone.

Thus the moult, considered as complete on December 28, and as originating on October 20, had taken 70 days, as compared with the 57 days required for a complete renewal of the coat in the spring.

A striking feature of the progress of the moult as compared with that of the spring is its complete reversal as to point of origin and direction of dispersal. It is a case of the first being last and last being first. Thus the spring moult originated on the post-auricular region of the head, whereas the fall moult terminated there. The fall moult originated on the ventral surface, and the sub-terminal tip of the tail, but the spring moult terminated there.

Once the moult had reached the dorsal area, patterns strikingly similar to those occurring in the spring resulted, though of course their direction was reversed. Comparison of Fig. A, B, C with Fig. C, B, A of the cited paper on the spring moult illustrates these similarities.

Colorado Museum of Natural History.

CAPTIVE FOX SQUIRRELS

By Ruth Dowell Svihla

The fact that fox squirrels (*Sciurus niger rufiventer*) are known to build nests in trees, and rear their young in them, has been reported by Stoddard (1920) for Indiana and Wisconsin. According to him, these are winter nests and are more compactly built than the loosely constructed summer nests. He states that in Wisconsin hollow trees are also used for nesting places by the squirrels. Sherman (1926) cites instances of fox squirrels making a nest in a box placed for flickers in a barn in Iowa.

Fox squirrels are evidently quite adaptable in regard to nesting

sites, to judge from our experience. In the early spring of 1928 a crow's nest, occupied by young, was located in a beech tree in a wood three miles southwest of Ann Arbor, Michigan (see Fig. 1). The following spring, on March 30, 1929, this same nest was examined and four young fox squirrels with eyes still closed, were found in it. The examination of the nest perhaps alarmed the mother squirrel, for a week later the young squirrels were gone.

In the same wood on April 22, 1928, a loose nest of willow leaves and twigs in the crotch of a willow tree not far from the top was discovered. The tree was climbed and the nest examined. At the first shake of the tree, a large fox squirrel appeared. In an attempt to catch it, the nest was knocked down and while the squirrel darted up the tree, four young ones fell the forty odd feet into the chilly water of a small pond immediately below. The young squirrels uttered shrill squeaks that lasted until they were rescued and wrapped up in a warm sweater. Meanwhile, the old squirrel, undoubtedly the mother, flattened herself against the tree so that it was difficult to distinguish her from the bark. Live traps were set to catch her, but with no success.

The young squirrels were infested with fleas. They still had their eyes closed, but were quite hairy, particularly about the neck and head, which had the characteristic pepper-and-salt color of the adult. The posterior parts were covered with short blackish hair, while the feet and tails were slightly rufous in color. The bellies had the least hair of any part, and this was merely tinged with rufous. The ventral median surfaces of the tails were entirely bare. The long hairs from the dorsal surfaces curled around to the under sides and pointed inward in direct contrast to the outward pointing hairs on the tails of adult squirrels. (I have noticed this same curling under of the dorsal hairs on the tails of young red squirrels.) The lower incisors had come through in all four of the young, but the upper incisors were not yet visible. The squirrels proved to be two males and two females, and on the latter 10 mammae were visible, 6 pectoral and 4 inguinal.

The young squirrels were taken home and raised on half cream and half milk, given by means of a medicine dropper three times a day. Cod liver oil and a little lime water were given every few days. Later, a yeast cake in small doses was mixed with the milk each week.

One eye of one of the squirrels began to open April 25, requiring two days to open completely. This may have been caused by an injury. It was certainly abnormal, for the other eye did not open until May 6, at which time the eyes of the other three squirrels also opened. A

marked increase in activity was now evident. They began to wash their faces, sit upon their haunches, and try to curl their tails over their backs. When hungry, they often uttered a low, chuckling grumble. They ate ravenously, stopping at no less than five or six and later eight dropperfuls (about ten cubic centimeters) of cream and milk for a meal. If placed in their box before they had enough to eat, they would often dig vigorously in the shavings which covered the bottom of the box as if to discover more food.

By May 17, the upper incisors of all four had appeared. On the tails the long hairs were straightening out so that instead of curling under, they now were at right angles to the median line and gave the tail a bushy appearance.

Gradually they were weaned from the cream and milk diet until they would drink water and eat rolled oats Cod liver oil was now mixed with the rolled oats. As their teeth became harder they enjoyed gnawing on dog biscuits and dry bread. By the first week in June they were quite able to take care of themselves and their teeth were so hard that they could eat black walnuts. During the summer they were turned into a large cage and fed dog biscuits and rolled oats mixed with cod liver oil. Nuts and lettuce were given them twice a week. Unfortunately, during a particularly hot spell, one of the females died.

Our absence during the summer caused a discontinuance of our observations until fall. By September 19, the three remaining squirrels had grown almost to adult size and were active and healthy. A supply of acorns, hickory nuts, and black walnuts was kept before them. Although they had been given black walnuts the previous spring, they had never offered to bury them. Now, in October, they were constantly burying nuts. They would dig in the debris in the corner of the cage, poke in an acorn or nut which was held in the mouth and cover it rapidly with debris, using an alternating sidewise movement of the front paws. Then sometimes they would pat it down before leaving. Later on in the fall they were given a pan full of earth. At first they were very curious about it and would pick up a lump and try to gnaw it. However, they soon learned to bury nuts in the earth as well as in the corners of the cage. A few experiments with buried nuts were made. They invariably found nuts buried in slightly moist earth, but failed to find them when buried in a tin pail of dry shavings. Dice (1927) found that a fox squirrel failed to discover nuts buried but slightly in dry sand. He suggests that nuts buried in damp earth may give off an odor which is recognized by the squirrel.

Hickory nuts were almost always eaten in preference to acorns. One day while the three squirrels were eating hickory nuts, they were timed. During eleven trials, involving all three squirrels, they averaged two minutes and fifteen seconds in consuming a nut. The last few nuts were eaten more slowly than the first ones, as the squirrels' hunger evidently became appeased.

On October 27, they were placed in another cage and given strips of paper for nest material. They had great fun with this. They would stuff it into their mouths, roll over, and then scamper about the cage, chasing one another. Finally they stored it away in the box for a nest. Here they all slept peacefully together, curled up so that nothing could be seen from the top of the box except bushy tails.

They were given a wire wheel which they soon learned to run expertly. Often one squirrel would lie crosswise in the wheel while the other two ran it, jumping over the prostrate one at each revolution.

Weights were taken of the squirrels at different intervals as follows:

	Females *grams*	Males *grams*
April 24, 1928	71.0	68.5
	75.5	70.0
April 30, 1928	80.0	70.0
	81.0	77.5
May 16, 1928	112.0	104.0
	113.0	107.0
Nov. 2, 1928	659.9	570.0
	644.5	
Febr. 5, 1929	970.0	835.0
	920.0	
May 27, 1929	730.0	720.0
	800.0	

From these data it will be seen that the squirrels had attained practically adult size by the first fall or by the time they were approximately eight months old.

As early as the last week in September, 1928, when they were at least six months old and perhaps not more than eight, the testes of the male squirrels became noticeable. By the third week in October, they measured approximately three centimeters in long diameter. The

males were often observed now to attempt to copulate with the female or with each other. (I have noticed similar precocious mating activities among young red squirrels.) They would chase the female about the cage until she was forced to take refuge in the nest box, there guarding the entrance by frequent pounces at the would-be intruders and by constant chattering and scolding. Here she would remain and the males were compelled to sleep curled up together in a corner of the cage. One of the males became more aggressive than the other and often chased him away from the food dish or the wire wheel which was now an envied possession.

Although these squirrels were kept under observation until June, 1930, and various combinations of matings were tried, no breeding took place. Two more females were obtained in the fall of 1929 and mated with the two males, but these also failed to produce young.

Chas. R. Conner Museum, Pullman, Wash.

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DESCRIPTION OF A NEW MUSTELID FROM THE LATER TERTIARY OF OREGON, WITH ASSIGNMENT OF PARICTIS PRIMAEVUS TO THE CANIDAE

BY E. RAYMOND HALL

[*Plate 5*]

This brief description of a small mustelid is offered in advance of a more extended paper on the entire group since Mr. C. L. Gazin and Professor Chester L. Stock have need of its formal designation in connection with their studies of the fauna of which this new form is one member.

Martes (Tomictis) gazini[1] subgen. et sp. nov.

Pl. 5, figs. *a–c*.

Type.—No. 391, Calif. Inst. Technology; left lower jaw bearing M_1, P_3, the alveolus of M_2, and the alveoli of P_4; from C. I. T. Palaeo. locality 57, 28 miles S.

[1] *Tomictis:* τομός, cutting; ἰκτις weasel or yellow-breasted marten; *gazini*, for Mr. C. L. Gazin.

of Harper and 3 miles N.W. of Skull Springs in Malheur County, Oregon. Collected by California Institute of Technology field party in summer of 1928.

Subgeneric diagnosis.—M_1: Talonid trenchant and short; metaconid present. The type is *Martes* (*Tomictis*) *gazini* Hall.

Specific diagnosis.—Size about as in *Mustela nigripes* Audubon and Bachman; M_1: metaconid slightly better developed than in *Martes a. americana* and with posterior margin directly medial to posterior margin of protoconid; talonid trenchant without suggestion of basining even at medial margin; talonid one-third as long as trigonid; P_3 without accessory cusp; mental foramen below middle of P_3; anterior margin of masseteric fossa below posterior margin of M_2.

Discussion.—*Tomictis* is of unusual interest because it tends to bridge the gap between *Martes* and *Mustela*. Whereas *M. gazini* has the metaconid present as in *Martes* rather than absent as in *Mustela*, the talonid is trenchant as in *Mustela* rather than semi-basined as in *Martes*. The differential dental characters of these two genera have been set forth by Gidley (Journ. Mamm., vol. 8, p. 248). In M_1 they are: In *Martes*, metaconid present rather than absent; talonid tending to be basined rather than trenchant which, in part, results in the assumption of a lateral position by the metaconid. Although these distinctions hold as between *Martes* (subgenera *Martes* and *Pekan*) on the one hand and *Mustela* (subgenera *Mustela* and *Putorius*) on the other, *Mustela* (*Lutreola*) *vison* has a semi-basined talonid. Thus, it follows that both *Tomictis* and *Lutreola* tend to bridge the gap between *Martes* and *Mustela*, though by a different combination of characters in each case.

Since no *Mustela* or undoubted ancestor of it possesses a metaconid on M_1, it seems best to maintain this character as applicable to the genus. Accordingly the new form from Oregon cannot be placed in *Mustela* on account of its possessing a metaconid. I propose, at least until the form is known from better material, to place it in the genus *Martes* to which it is seemingly as closely related as it is to *Mustela*. The long, ventrally convex jaw is more suggestive of *Martes* than *Mustela*. However, the new species does not fit into either of the subgenera, *Martes* or *Pekan*. Neither does it belong in *Plionictis* Matthew (Bull. Amer. Mus. Nat. Hist., vol. 50, p. 135) which, although it includes widely divergent forms, is characterized throughout by a basined or semi-basined talonid on M_1. In view of these facts, and in spite of a confessed dislike of designating new subgenera, especially in small groups, it seems best to distinguish *Martes gazini* under the subgeneric name *Tomictis*.

An edentulous palate from the same locality as no. 391 represents a larger animal than the one to which the lower jaw pertains. Knowing that in certain species of the genus *Martes*, variation in size due to sex and individual peculiarity is as much as twenty per cent, even in length of teeth, it seems probable that the palate pertains to a male and the lower jaw to a female.

Measurements.—Anterior border of P_3 to posterior border of M_1, 17.5 mm.; length of P_3, 4.3; length of M_1, 8.4; length of the single alveolus of M_2, 1.7; depth of mandible at posterior border of M_1, 10.4.

Parictis primaevus Scott

Pl. 5, figs. *c–d*

Parictis princeous Scott, Amer. Nat., vol. 27, p. 658, July, 1893. Name held by Hay (Bull. no. 179, U. S. G. S., p. 767) to be a misspelling of *Parictis primaevus*.

Type.—No. 10583, Princeton Univ. Palaeo. Coll., fragment of left lower jaw bearing posterior half of alveolus of canine, medial and posterior walls of alveolus of P_1, P_2 and P_3 entire, roots of P_4, alveoli of M_1, and M_2 and anterior two-thirds of one alveolus of M_3; from Camp Creek, Oregon, John Day Oligocene, Princeton Scientific Expedition, 1889.

Description.—The dental formula of the lower jaw is $_3?, _1, _3, _3$; P_1 seems to have been single rooted; P_2 and P_3 each has two roots; one central pointed cusp without accessory cusps; strong cingulum entirely around tooth; well developed talonid; entire surface of crown above cingulum fluted and roughened; tip of cusp worn; this wear is slightly greater in amount on P_2 than on P_3.

P_4, M_1 and M_2 are double rooted. Loss of the posterior part of the jaw has carried away all but the anterior two-thirds of one alveolus of M_3. The anterior margin of the masseteric fossa extends to a point behind the anterior margin of M_3, if that tooth is single rooted. The medial face of the mandible is slightly concave from a point below the middle of M_1 posteriorly as far as the mandible is preserved, which is not as far as the inferior mental foramen.

The fact that the specimen is greenish gray, except the crowns of the teeth which are brownish, may be of interest to palaeontologists who are familiar with the stratigraphy along Camp Creek.

Selected measurements.—Anterior margin of anterior root of P_2 to posterior margin of alveolus of M_3, 26.7 mm.; crown length of P_2 and P_3, each, 5.0; alveolar length of M_1, 7.1; alveolar length of M_2, 4.1; depth of mandibular ramus below posterior root of P_2, 9.7; depth below posterior root of M_2, 10.8; breadth of mandible below posterior root of P_4, 4.8.

Remarks.—Through the courtesy of Dr. William J. Sinclair, I have been able to examine *Parictis primaevus* Scott and to present the first published figure of it. Although this form has been generally regarded as a genus of the Mustelidae it seems to be at most remotely related to that family and, for the present, seemingly, is best referred to the Canidae. This view rests on the possession of a complete dentition which is not present in any undoubted genus of the Mustelidae, and on the form of P_2 and P_3 which, at least to me, suggest some early canid rather than mustelid. As regards structural features and position in time *Parictis* occupies a place among the new world Carnivora similar to that of *Pachycynodon* or *Cynodon gracilis* Filhol among the old world Carnivora (see Schlosser, Die Affen, Lemuren, etc., 1888, p. 258, pl. 9).

EXPLANATION OF PLATE 5

Mandibles and Lower Teeth of Two Carnivores

Photographs retouched by Mrs. Frieda L. Abernathy.

a. Martes (*Tomictis*) *gazini* X1; lateral view of type specimen, no. 391, Calif. Inst. Technology, from C. I. T., Palaeo. locality 57, 28 mi. S. of Harper and 3 mi. N.W. of Skull Springs in Malheur Co., Oregon.

b. Martes (*Tomictis*) *gazini* X2, crown view of type specimen shown in *a*.

c. Parictis primaevus X2; crown view of type specimen, no. 10583, Princeton Univ. Coll., from Camp Creek, Oregon, John Day Oligocene.

d. Parictis primaevus X2; lateral view of type specimen shown in *c*.

a
b
c
10583
d

ALILEPUS, A NEW NAME TO REPLACE ALLOLAGUS DICE, PREOCCUPIED, AND NOTES ON SEVERAL SPECIES OF FOSSIL HARES

By Lee R. Dice

The generic name *Allolagus* Dice with type species *Lepus annectens* Schlosser was published on November 11, 1929. On August 1 of the same year the same generic name *Allolagus* had been published by Ognev, who selected as type species *Lepus mandshuricus* Radde. Ognev's name obviously has priority, and a new name is necessary for the genus containing the species *Lepus annectens*.

Genus **Alilepus**, new name

1929. *Allolagus* Dice, Jour. Mammalogy, Vol. 10, p. 342. November 11, 1929 (Not *Allolagus* Ognev, Zool. Anz., vol. 84, pp. 71–73, August 1, 1929).

Type species.—*Lepus annectens* Schlosser, Palaeontologica Sinica, ser. C., vol. 1, fasc. 1, p. 44, pl. 3, figs. 37, 37a, 38a. 1924.

Alilepus laskarewi Khomenko

Khomenko[1] has described as *Lepus laskarewi* a fossil hare from the vicinity of the village of Taraklia, which is now in Rumania. The beds are perhaps of Miocene age. The figure given of the enamel pattern of the third lower premolar shows that this species belongs to the subfamily Palaeolaginae[2] and should be placed in the genus *Alilepus*. The species differs from *Alilepus annectens* according to the published figures in that the length of the third lower premolar is greater, this greater length being chiefly in the region in front of the main pair of reentrant angles. Also there is on the exterior face of this tooth a second shallow reentrant angle anterior to the main reentrant angle.

(?) **Caprolagus valdarnensis** Weithofer

Lepus valdarnensis Weithofer[3] was originally described from part of a skull from the Pliocene of the Val d'Arno, Tuscany. Lower jaws were later found and figured,[4] but I have been unable to find a figure of the enamel pattern of the teeth of these specimens. The species has been referred to the genus Caprolagus by Major.[5]

A fossil hare from Malusteni, Rumania, has been assigned by Simionescu,[6] to *Lepus valdarnensis*. The age is supposed to be upper Pliocene. The enamel pattern of the lower third premolar, as figured, indicates a member of the sub-

[1] Kisinev Trav. Bessar. nat., vol. 5, p. 11, pl. 1, figs. 9, 10, 19, 20. 1915.
[2] Dice, Journ. Mammalogy, vol. 10, p. 340. 1929.
[3] Jahrb. k. k. Geol. Reichsanstalt, vol. 39, part k, pp. 80–81. 1889.
[4] Bosco, Palaeontographia Italica, vol. 5, pl. 12, fig. 7. 1899.
[5] Trans. Linn. Soc. London, ser. 2, Zool., vol. 7, p. 514. 1899.
[6] Acad. Romana, vol. 9, no. 49, pp. 23–26, pl. 2, fig. 11; figs. 36–37. 1930.

family Palaeolaginae, and this fossil form therefore cannot be placed either in the genus *Lepus* or the genus *Caprolagus*, both of which genera are in the subfamily Leporinae. Although the Malusteni form differs in the character of the enamel pattern of the third premolar from both *Alilepus annectens* and *A. laskarewi* it apparently belongs to the genus *Alilepus*.

The Malusteni form seems to differ in certain respects from the Val d'Arno species, *valdarnensis*, but the published figures and descriptions are inadequate for proper comparison. Although the Malusteni form almost certainly should be placed in the genus *Alilepus*, it is not at all certain that *valdarnensis* belongs to the same genus.

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PRELIMINARY DESCRIPTIONS OF FOUR NEW NORTH AMERICAN GROUND SQUIRRELS

By Arthur H. Howell

Critical studies of the North American ground squirrels have brought to light several undescribed forms additional to those previously published by the writer.[1] These are here briefly described in advance of a more formal paper.

Citellus beecheyi parvulus subsp. nov.

Type.—Female subadult, skin and skull No. 28068/40167, U. S. National Museum (Biological Survey collection); collected in Shepherd Canyon, Argus Mountains, California, April 30, 1891, by A. K. Fisher; original number, 569.

Subspecific characters.—Similar in color and cranial characters to *Citellus b. fisheri*, but smaller; smaller and paler than *beecheyi*.

Measurements.—Type (subadult ♀): Total length, 410; tail vertebrae, 169; hind foot, 50; ear from notch, 17. Average of 8 adult males (Argus Mountains, Panamint Mountains, Owens Lake): 406.6; 161.6; 54.6; 19.6. Average of 12 adult females from same localities: 410; 163; 52.9; 19.

Skull: Average of 7 adult males: Greatest length, 56.3; palatal length, 26.8; zygomatic breadth, 35.3; cranial breadth, 23.3; least interorbital breadth, 12.8; least postorbital breadth, 14.9; length of nasals, 20.9; maxillary tooth row, 11.1. Adult female (type): 54.1; 26; 33.3; 23.3; 14; 16.4; 19.4; 11.1.

Range.—Desert ranges of southern California and northern Lower California, from Owens Valley and the Panamint Mountains south to the San Pedro Martir Mountains.

Remarks.—This small, pale race intergrades with *fisheri* at the southern end of the San Joaquin Valley and with *beecheyi* in the San Bernardino, San Jacinto, and other ranges in southwestern California.

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[1] Proc. Biol. Soc. Washington, vol. 41, pp. 211–214, 1928.

Callospermophilus chrysodeirus connectens subsp. nov.

Type.—Male adult, skin and skull, No. 212461, U. S. National Museum (Biological Survey collection); collected at Homestead, Oregon, June 1, 1916, by H. H. Sheldon; original number, 535.

Subspecific characters.—Similar in summer pelage to *C. chrysodeirus chrysodeirus*, but head and mantle darker; shoulders and fore back more vinaceous (less ochraceous); under side of tail paler. Similar in color to *C. chrysodeirus castanurus* but under side of tail paler, and sides of face and neck paler (more ochraceous).

Description of type (summer pelage).—Head, ears, shoulders, and sides of neck russet, shading on sides of face and neck to cinnamon-buff; nape and fore back between the shoulders cacao brown; median dorsal area fawn color, shading to army brown on rump and thighs; sides of body and feet pinkish buff; light dorsal stripes creamy white, tinged with pinkish buff, bordered on each side with shorter black stripes of the same width; tail beneath, cinnamon; tail above, mixed with fuscous-black; underparts grayish white, washed with pale pinkish buff.

Measurements.—Type (♂ adult): Total length, 275; tail vertebrae, 95; hind foot, 42; ear from notch (dry), 14. Average of 16 adults (7 males, 9 females): 266; 91.9; 41.2; 14.3. *Skull:* (Type): Greatest length, 44.1; palatal length, 20; zygomatic breadth, 27.1; cranial breadth, 19.1; least interorbital breadth, 9.6; least postorbital breadth, 12.3; length of nasals, 14.8; maxillary toothrow, 8.8.

Range.—The Blue Mountains region of northeastern Oregon and southeastern Washington.

Callospermophilus chrysodeirus mitratus subsp. nov.

Type.—Male adult, skin and skull, No. 138125, U. S. National Museum (Biological Survey collection); collected on South Yolla Bolly Mountain, California, July 30, 1905, by J. F. Ferry; original number, 13.

Subspecific characters.—Similar to *Callospermophilus c. chrysodeirus*, but upperparts paler and more grayish (less brownish), especially on the rump; mantle darker; tail averaging longer and darker beneath; hind feet longer; skull larger. Compared with *trinitatis:* Upperparts much paler; mantle darker and more extensive; skull broader across zygomata; external measurements smaller.

Description of type (summer pelage).—Head and mantle russet (this color extending to the shoulders and fore back), shaded on sides with ochraceous-tawny; throat and sides of lips warm buff; median dorsal area and rump smoke gray; light dorsal stripes creamy white, bordered on each side with black stripes of about the same width; sides of body pale pinkish buff; feet cinnamon-buff; tail above, fuscous-black, mixed with warm buff; tail beneath, deep tawny, bordered with fuscous-black, and edged with warm buff; underparts pinkish buff.

Measurements.—Type (♂adult): Total length, 282; tail vertebrae, 110; hind foot, 42; ear from notch (dry), 14.5. Average of 10 adults (5 males, 5 females) from type region: 269; 94.1; 41.4; 14.5. *Skull* (of type): Greatest length, 43.6; palatal length, 20.5; zygomatic breadth, 28; cranial breadth, 20.8; least interorbital breadth, 9.9; least postorbital breadth, 12.7; length of nasals, 15.9; maxillary toothrow, 7.9.

Range.—Mountain ranges of northern California, from Glenn County north to southern Siskiyou County.

Remarks.—This race is most strongly developed in the region around South Yolla Bolly Mountain. A large series (in the Museum of Vertebrate Zoology) from northern Trinity and southern Siskiyou counties agree in size with typical *mitratus*, but are slightly darker; their skulls average a little longer, and narrower across the zygomata, thus showing approach to *trinitatis*.

Ammospermophilus leucurus pennipes subsp. nov.

Type.—Female adult, skin and skull, No. 75683, U. S. National Museum (Biological Survey collection); collected at Grand Junction, Colorado, November 11, 1895, by A. H. Howell; original number, 494.

Subspecific characters.—Similar to *Ammospermophilus l. cinnamomeus*, but upperparts in winter pelage more grayish (less vinaceous) and in summer pelage darker and more brownish; skull slightly larger. Compared with *A. leucurus leucurus:* Coloration in summer pelage decidedly more vinaceous (less grayish); in winter pelage rather similar, but averaging more vinaceous; skull decidedly larger.

Description of type (winter pelage): Upperparts light vinaceous-cinnamon, the hairs on the median dorsal area tipped with white; flanks and hind legs vinaceous-cinnamon, shading to pale pinkish buff on the hind feet; front feet similar; lateral stripes creamy white; tail above, mixed black and white, the hairs showing a broad, subterminal band of black; tail beneath, creamy white; underparts white, the bases of the hairs plumbeous.

Measurements.—Type (♀ adult): Total length, 229; tail vertebrae, 76; hind foot, 41; ear from notch (dry), 9. Average of 10 adults (4 males, 6 females) from type locality: 226.6; 68.8; 39; 8.7. *Skull* (of type): Greatest length, 40.8; palatal length, 18.5; zygomatic breadth, 23.4; cranial breadth, 19.2; least interorbital breadth, 10.1; least postorbital breadth, 14.5; length of nasals, 12.7; maxillary toothrow, 6.9.

Range.—The Colorado Valley and its tributaries (except the San Juan) in western Colorado and eastern Utah; specimens examined from Grand Junction, Hotchkiss, Fruita, and White River, 20 miles east of Rangely, Colorado; Vernal, Thurber, and Henry Mountains, Utah.

GENERAL NOTES

OPOSSUM AND SPOTTED SKUNK IN BLUE EARTH COUNTY, MINNESOTA

During December, 1927, an animal new to townspeople and farmers of the vicinity was caught in Rapidan, Minnesota, and was identified as an opossum by use of pictures in Burgess' *Animal Book for Children*. Though the writer did not see or obtain the body he does not hesitate to believe the determination good. During the following summer an adult with seven young was reported killed in Goodthunder, and another with two young was seen at St. James, a few miles west of Blue Earth County. There seems nothing to indicate how these animals came to be there.

Range maps for the *Spilogale* (presumably *interrupta*) usually show its distribution to end abruptly along the southern boundary of Minnesota an expression of uncertainty. Bernard Bailey has recorded it from Sherburn County, Minnesota

(Journal of Mammalogy: 10, No. 2, 1929). The present writer has taken four specimens of it near Mankato, Minnesota—one during each of the years 1917, 1918, 1920, and 1922. It may be rated as common in the county, being well known by farmers.—CARL MOHR, *Rapidan, Minn.*

NEST AND YOUNG OF SOREX VAGRANS VAGRANS

On Saturday, October 4, 1930, Leonard Scott and I went in search of salamanders on one of our favorite "stamping grounds", a brush covered hillside above a good sized slough. Our searching brought us to the base of the hill where upon overturning an old railroad tie we discovered two nests made of loosely-woven grass, and six nearly grown shrews.

The smaller of the two nests was composed of fine grasses and I supposed that it was occupied by the shrews while they were very young; the larger nest, constructed of coarser grasses, was the one later occupied.

I was not very excited when glimpsing the first shrew as I often came upon a dead one, but when I grasped it and saw that it was only one of six scattered about the leaves and earth, shrew hunting became more exciting for a few minutes. They ran and hid in the leaves and one had to be dug out from under the surface of the earth; of the six captured, all were young; the old female was not seen.

Nests observed later proved to be composed of both grasses and balls of leaves. In one leaf nest was found an adult female without any young, but having enlarged milk glands.—STANLEY G. JEWETT, JR., *Portland, Oregon.*

A NOTE ON TWO SPECIES OF SHREWS

In my earlier researches on the genus *Sorex*, I identified a specimen from Alpha, Lewis County, Washington, as *Sorex obscurus bairdi*, and recorded it as such in my monograph (North American Fauna No. 51, p. 140, July 24, 1928). A more recent examination of the specimen (No. 54283, Univ. Michigan Museum of Zoölogy) shows that, although intermediate in color, size, and cranial characters between *Sorex obscurus bairdi* and *Sorex obscurus setosus*, it is referable to *setosus*. The subspecies *bairdi*, therefore, should be eliminated from the Washington list.

I am indebted to Dr. R. M. Anderson for calling to my attention a transcription wherein two specimens from Rossland, British Columbia, that were identified as *Sorex obscurus obscurus*, are recorded under *Sorex obscurus setosus* (North American Fauna No. 51, p. 136). The original identification of these two specimens as the subspecies *obscurus* was correct; the records were in some way misplaced in the manuscript.

In the above-mentioned publication (page 70), I referred one specimen of *Sorex arcticus* from Aweme, Manitoba to the subspecies *arcticus* while two others from the same locality were referred to *Sorex arcticus laricorum* (page 72). As indicated in my monograph, specimens of this species from the region of Aweme are intermediate in characters between the two forms. A recent examination of additional material from that locality in the collection of Stuart Criddle, however, shows that the average characters approach more nearly the subspecies *laricorum*, with which all the specimens may be identified.—HARTLEY H. T. JACKSON, *U. S. Biological Survey, Washington, D. C.*

A FEEDING HABIT OF THE LONG-TAILED WEASEL

Popular natural histories frequently refer to the slender, elongated form of weasels in general as an adaptation that permits them to penetrate with ease to the depths of small burrows and similar laybrinths in pursuit of rodent prey. Such ability is of unquestioned value to the animal, but recent observations on a captive long-tailed weasel (*Mustela l. longicauda*) suggest another utility for a slender body that may be of equal economic importance.

On various occasions in feeding the weasel, it was given live small mammals, chiefly brown rats and chipmunks. On these occasions, it was customary to liberate the two animals, rodent and weasel, in a large room where there was ample space to scamper and dodge about. Once the weasel sighted its prospective prey, it began a relentless chase that always ended in the same way. Quickly it would reduce the intervening distance and when within striking distance would seize its victim by the handiest portion of its anatomy—then with amazing rapidity throw its body in a loose, snake like coil over the rodent's body, a move which served effectively to subdue its frantic struggles, and then while holding it thus, would shift its initial grip to the back of the head for a killing bite, driving its canines through the brain case or disrupting the neck vertebrae.

A glance at this successful little predator shows its feet to be weakly clawed and relatively poor equipment for seizing and holding small and elusive prey, but the serviceability of its snake like body for a similar purpose needs only be seen to be appreciated.—FREDERIC W. MILLER, *Colorado Museum of Natural History, Denver, Colo.*

THE HOUSE CAT AS A COLLECTOR OF MAMMALS

A very novel method of collecting small mammals has resulted from the activities of a cat belonging to Professor H. H. Caldwell, of the Department of English, University of Florida, Gainesville, Florida. This cat, solid black in color, is a very efficient mouser, but its activities have not been confined to the ordinary house mouse, nor has it been prompted, apparently, by hunger alone.

On the morning of November 11, 1928, this cat laid at the front door a female mole, *Scalopus aquaticus parvus* Rhoads, which was dead, but otherwise in perfect condition. On November 20, 1928, a female short-tailed shrew, *Blarina brevicauda peninsulae* Merriam, was likewise brought to the door, and another female of the same species on December 1, 1928. Another specimen of the above species of mole was captured on January 17, 1929; and on January 3, 1929, a male specimen of the Florida Pine Mouse, *Pitymys parvula* Howell. Two more specimens of the Pine Mouse were captured; a female on March 3, 1929, which was brought up in the usual manner, with the exception of its being somewhat mutilated; and a male on March 24, 1929, which was discovered in the evening about dusk, as the cat was tossing it about playfully. The latter specimen was still alive when taken from the cat.

As these animals, with one exception, were undamaged, and furthermore, as the cat is well fed, they must have been caught more for sport than as an addition to the menu.

The skins of these specimens are in the Florida State Museum, Gainesville, Florida.—O. C. VAN HYNING, *Cornell University, Ithaca, N. Y.*

SOME LATE RECORDS OF THE TIMBER WOLF IN PENNSYLVANIA

The Timber Wolf (*Canis nubilus* Say), or some of the related species, formerly ranged over the most of the eastern United States, and the dates of last appearance in particular sections have usually not been recorded.

The writer has heard since childhood of one wolf killed in the height of land, 30-odd miles northeast of Williamsport, Pennsylvania, and while inquiring for details from better informed persons last summer (1930) another and later record was found from the same range of hills, but a few miles to the westward. These may be the last records for the state, as this section was not well settled at the time, and most of it was covered with the magnificent forests of hemlock, maple cherry, white pine, oak, and chestnut, for which the state was noted. The first mentioned wolf was killed in the summer of 1867, as near as several accounts agree. It had killed eleven sheep, and a string gun was set by Samuel Battin in a pasture. The wolf was wounded, and a number of men tried to trail it, but finally all gave up but Samuel Battin, Henry Williams and L. D. Porter, who after several days found it in a laurel swamp, near the line between Sullivan and Lycoming Counties. Most of this was told by Mr. Sumner McCarty, of Hillsgrove, Penna., a grandson of Samuel Battin, and it agrees in all essentials with the tale as told by others years ago; the date is probably correct, certainly within a year.

The second record was furnished by Mr. Fred Trippe, of Canton, Pennsylvania. This wolf was killed within a few miles of Ralston, in the year 1872, by Levi Kissenger. He was told the story by two old hunters, and this is as authentic as such passed-down tales can ever be.

Wolves must have been not uncommon a few years previous to these times, as the offering of bounties indicate, and stories concerning them still are known. A Quaker caught a neighbor's dog, as he supposed, in a trap; when he released it and gave it a kick, he told it "Thee go home." That, too, was a wolf.—IVAN R. TOMKINS, *Savannah, Ga.*

A SIXTH COLORADO RECORD OF PHENACOMYS

The rodent *Phenacomys* is of sufficiently rare occurrence in the southern Rocky Mountain states to make each new record of its capture a matter of interest. It is our purpose, in the present note, to record the sixth known specimen of the genus from the state of Colorado.

On July 13, 1930 while on an over-night trip to Alma, Park County, we set out a short line of mouse traps along the meadows bordering the headwaters of the South Platte and on the high ground immediately above them. Despite a night of continued showers the traps, on the following morning, produced a goodly catch of *Peromyscus*, *Microtus*, *Zapus*, *Sorex*, and a single specimen of *Phenacomys intermedius intermedius* Merriam. The set at which the latter was secured had been placed at the foot of a medium sized spruce in a sparse thicket of aspens on the bank of a brook tributary of the Platte. About the roots of the spruce there were a number of small holes, much frequented during the day by chipmunks.

The specimen, No. 2410 C. M. N. H., is a young adult male, measuring total length, 130 mm., tail vertebrae, 27 mm., hind foot, 17 mm.; its stomach was crammed with a mass of finely chewed, unidentifiable plant material.

We returned to the locality July twenty-first, remaining until the twenty-sixth, during which period we thoroughly trapped every ecological association in

(Oct. 13) became distinctly gray, although it has been in the same cage with the normal brown laboratory stock since September 5 and has been exposed to very little sunshine. The fifth taken from the laboratory to my home on September 6 now has the characteristic gray blotches on its face.

Shedding possibly accompanies this color change, although there is no direct proof of it. The sharply delimited spots on the head and the persistent brown specks suggest that it is not a fading of the hair already present. The widely different time of fading in the four individuals may be due to age differences showing up in shedding time. The continuance of the process upon removal from the sunshine to the laboratory, and the fact that those which became grayest lost most of their tail hair point to the same conclusion. Yet it will probably be necessary to observe these individuals during the period of a year or so to be sure of these things.

The causative agent was probably the unusual amount of direct sunshine to which the four were subjected. Other environmental factors might be responsible. The diet of the dozen laboratory animals, all of which have remained normal in color, has consisted almost entirely of wheat and milk with occasional green food. That of the others has been the omnivorous diet of the ordinary domestic cat, plus plenty of green food and fruit. The temperature changes out of doors have of course been much greater, especially during the middle of the summer when 90 to 100°F in the direct sunlight must have been frequent.

Such profound color changes produced by rather minor differences in environment make one wonder if some naturally occurring variations may not be due to immediate effects of environment such as these. It would be interesting to know what would happen to various subspecies of *Tamias striatus* raised under identical conditions in the laboratory. Would their subspecific color differences remain evident?—H. W. Mossman, *Dept. of Anatomy, Univ. of Wisconsin.*

RANGE OF THE ALLEGHENY CLIFF RAT IN THE SOUTHERN APPALACHIANS

The Allegheny Cliff Rat (*Neotoma pennsylvanica*) is known to range southward through eastern Kentucky and Tennessee to the Tenneessee River in northern Alabama.[1] Although its presence in the mountains of North Carolina and Georgia has long been suspected, apparently no conclusive evidence of its occurrence in either of those states has been obtained until the past season (1930), when a single specimen was taken on June 26 in a trap set in a cabin near the old Ravenel Mill on Cove Creek, near Highlands, North Carolina.

Rhoads, in 1896,[2] recorded the animal from "the cliffs of Roan Mountain and other peaks of the Southern Alleghenies," evidently on the testimony of the natives of the country, for he makes no mention of having seen or captured a specimen.

Pickens, writing of South Carolina,[3] states that he has found evidences of the animal's presence in the Saluda Mountains and near Little Rich Mountain.

During a collecting trip of several weeks in the higher mountains of North Carolina (Mount Mitchell, Grandfather Mountain, and Clingman's Dome (Great Smoky Range) I searched in every suitable situation for signs of this rat but found

[1] Howell, North Amer. Fauna No. 45, p. 53, 1921.
[2] Proc. Acad. Nat. Sci. Philadelphia, p. 192.
[3] Journ. Mamm., vol. 9, p. 156, 1928.

none. Our work was carried on chiefly in the Canadian Zone, at altitudes between 4,000 and 6,500 feet, and the absence of any signs of this species in the region covered suggests that the animals do not range much into that zone. The specimen taken at Highlands was in Transition Zone (4,000 feet), and that seems to be the zone most favored by this species, though it ranges also through the Upper Austral and even into the upper edge of Lower Austral in Alabama and Tennessee. Further search will undoubtedly reveal its presence in the mountains of both South Carolina and Georgia.—ARTHUR H. HOWELL, *U. S. Biological Survey, Washington, D. C.*

PORCUPINE IN MARIN COUNTY, CALIFORNIA

A few days after its occurrence, my son, Ernest C. Mailliard, told me of a surprise that he had experienced on the morning of October 13, 1930. On that date, quite early but in broad daylight, he was driving down grade on a narrow hill road through coniferous county near Alpine dam, Marin County. Incidentally a little rain in the previous night had made the road sufficiently slippery to necessitate slow and careful driving. As he turned around one of the many sharp points in the road he was astonished to come upon a porcupine, presumably the Yellow-haired (*Erethizon epixanthum epixanthum*), squarely in front of his car.

Not wishing to harm the animal, and with visions in his mind of barbed quills in the tires, he stopped as quickly as possible on such a slippery roadway, but could not avoid going over the "porky." Apparently the animal had escaped serious injury, for it had disappeared over the road bank by the time that he was able to get out of the car to investigate.

After having lived a great part of the past sixty-odd years in that part of Marin County, ranching, hunting, fishing, collecting specimens, always on the lookout for new bird or mammal, this is the first occurrence of the porcupine in that or any part of the San Francisco Bay region that I have known or heard of. It is, however, common in the high Transition zone a couple of hundred miles north of San Francisco, perhaps somewhat nearer, and along the Sierra Nevada. My son lived for a while in Trinity County, where it is very common, and is thoroughly familiar with its appearance.

The porcupine does not seem to be well adapted to the rôle of household pet, but with the present constant stream of tourists, largely of none too high a grade of mentality, only too often disrupting our scheme of orderly distribution of wild life, there is no telling what might happen anywhere. In any event, even if the presence of this porcupine in Marin County was brought about by tourist agency, it seems worth while to publish this report in case of its proving to be a primal record of erethizonic invasion of this territory.—JOSEPH MAILLIARD, *California Academy of Sciences, San Francisco, Calif.*

NOTES ON ANTLER GROWTH OF CERVIDAE

This note on the antler growth of the Cervidae of New Brunswick, Canada, was suggested by the discussion of the subject at the meeting of the Society in New York City in May, 1930. A certain caribou head, mounted by a taxidermist friend, had antlers that were covered with hair much longer than that of the so-called velvet which still adhered to the antlers late in the fall, sometime after the shooting season opened. Later examination revealed the facts that the molars were worn down nearly to the gums, and that the animal was in a run-down condition,

and consequently the velvet of the antlers had not developed properly, as would have been the case if the teeth had been in good condition. Apparently the vitality of the animal was not sufficiently great to ripen the velvet as usual, that it might be sloughed at the proper time of year.

This same taxidermist also obtained a large old deer that had mere excuses for antlers, they were so stunted and abnormal. This animal while in good fat condition had lost its molars, and this evidently was the cause for the deformed antler growth.

At taxidermist shops that I have visited my attention has always been directed toward the study of the teeth as compared to the balanced formation of the antlers, and whenever a deformed antler has been found there has been one or more of the molars in bad condition on the same side of the head, and when both antlers were of poor quality the teeth on both sides were in poor condition. It is certainly very singular that poor molars on one side should affect only the antler on the same side, but such is the case in several instances that were carefully studied. One set of moose antlers in my possession at present are evidently a reduced replica, in size and development, of the form grown by the same animal when in his prime, but the present set is a sorry makeshift, and the condition of the teeth showed that the bearer was aged and much past his prime. The same condition prevails with our deer (*Odocoileus virginianus*) as has been cited in relation to the caribou and moose.

Another interesting phenomenon that attracted my attention was a strain of moose that had nine incisiform teeth instead of the normal number of eight. No example of this abnormality could be secured, as such specimens in all cases belonged to nonresident sportsmen.—Wm. H. Moore, *Scotch Lake, N. B.*

A MOUNTAIN SHEEP RECORD FOR NEBRASKA

While it is well known that mountain sheep ranged in certain favored localities in Nebraska at the time the region was first visited by white men, and for a time thereafter, actual records of specimens native to the state are not numerous.

In the collections of the Cook Museum of Natural History is a fairly well preserved skull and horns (No. 101M) of a moderately large male, which was found in the rough Lower Harrison formation hills, about 23 miles south of Agate, Nebraska, near the head of the breaks that drain from that point down to the North Platte valley. There are no special characters about the skull to mark it as in any way unusual. The specimen owes its good state of preservation to the fact that it was lying in a small cave-like shelter, perfectly dry and well protected from moisture. It seems quite probable that the sheep had died in there, and that pack-rats had carried off all the smaller bones leaving only the heavy head and horns in the shelter. Being in a spot which is rather difficult of access, it had long escaped observation or damage.

The locality is about 25 miles north of Scottsbluff, where mountain sheep also once ranged, in the high divide between the North Platte and Niobrara river valleys, and about 15 miles east of Spoon Butte, which is directly on the Wyoming-Nebraska state line. Spoon Butte is a famous local land-mark on the old military road from Fort Laramie, Wyoming, to Fort Robinson, Nebraska (on the Red Cloud agency), and derived its name from the fact that mountain sheep used to be abundant there. The name evolved from the Big Horn, or "Great Horn Spoon," i.e., ladle-like "spoons" made from the horns of these sheep,—which

were in common use by the Sioux and other tribes before trade utensils from the whites were available. In the Cook Museum of Natural History are "spoons" of this type, from this region, which were made and used by the Sioux.

The writer saw parts of badly weathered mountain sheep remains on Spoon Butte in 1909, while doing field work for the American Museum of Natural History in that area; but no specimen was collected. James H. Cook, father of the writer, who has known this region since about 1876, remembers having seen horns and other remains of mountain sheep in some numbers about Spoon Butte, years earlier, at which time their appearance would suggest that their owners had been killed but a few years before.

Some years ago the writer saw a weathered pair of mountain sheep horns picked up in the rough hills of the Hat Creek breaks, in northern Sioux County, some thirty miles north of Agate, Nebraska, and has neard of others found in the same hills. This information is from sources that are probably reliable. The topography here is adapted to the habits of these animals, being rugged and picturesque, so that it is not surprising that they ranged here, when not hunted out by man.—HAROLD J. COOK, *Cook Museum of Natural History, Agate, Nebr.*

RECENT LITERATURE

F. Wood Jones. MAN'S PLACE AMONG THE MAMMALS. 372 + xi pages. New York and London. 8 vo. 1929.

This work of nearly 400 pages contains a detailed exposition of Professor Wood Jones' ideas concerning man's ancestry. The book is divided into three parts. Part I discusses "The evolution of biological thought" (44 pages), and part II "The evolution of thought concerning man" (23 pages). Part III (297 pages) deals with "The Primates." The bulk of this third part is concerned with a more or less systematic treatment of the external and internal characters, habits, paleontology, and genetic affinities of the various groups of Primates. The concluding pages are devoted to man and the problem of his ancestry.

The main conclusions of the author may be summarized as follows: The Lemuroidea have no rightful claim to be included among the Primates. They possess certain fundamental and peculiar characters in common with the tree-shrews (Tupaiidae), which are in reality primitive lemurs. Grouped together, the lemurs and tree-shrews form a natural and distinct mammalian division, the Strepsirhini. The actual Primates, or Haplorhini, include therefore only the New and Old World monkeys, the gibbons, the three great apes, *Tarsius* and man. *Tarsius* is in no wise a lemur, but a Primate, the somewhat specialized, yet essentially primitive survivor of the tarsioid stock which gave rise to the existing Primate groups. From this early tarsioid stock there arose three lines of development. One of these produced the Platyrrhine or New World monkeys. A second culminated in the Catarrhine or Old World (Cynomorph) monkeys. The gibbons, orang-utan, chimpanzee and gorilla are rather early offshoots of this Old World stem and they (particularly gibbon and orang), have thus avoided many of the "pithecoid" specializations which have attained their fullest development in the Cynomorph monkeys. The third line evolving from the early tarsioids led to man. Man therefore bears only remote kinship to the

monkeys and anthropoid apes. The modern *Tarsius* is the sole survivor of the original primitive Haplorhine stock.

A serious defect in the author's presentation and argument lies in his uneven treatment of the evidence available from studies on various parts of the body. His conclusions appear to be based mainly upon a consideration of cranial characters, an attitude which I can only regard as unfortunate. This method of treatment, with undue emphasis on the cranium, is archaic, and harks back to the days when skeletal material, and skulls in particular, all but constituted our total knowledge of the Primates other than man.

In the index of Professor Wood Jones' book there are 13 references to the pterion, a cranial character of very limited phylogenetic value because of the vagaries of growth processes in that region. On the other hand, the 10 references to the muscle system are all scanty and totally inadequate. Surely the musculature is at least as important phylogenetically as the pterion. And it cannot be denied that we are at the present time, despite certain gaps in our knowledge, possessed of very important data on this system in Primates. Other soft parts receive relatively scant consideration. The references to the brain (11 in the index) are all of a generalized nature. Only 16 lines are devoted to the brain in the general final discussions. The author regards the striking likenesses of the human and anthropoid ape brains as entirely due to parallelism. In support of this contention he refers to the remarkable parallel development of the brains of Platyrrhines and Catarrhines. The section on placentation is limited to quotations to show that *Tarsius* exhibits developmental affinities with the monkeys, apes and man rather than with the Lemuroidea. No reference is made to the important contributions to Primate placentology made by Selenka, Strahl and Wislocki, studies which indicate man's close affinity with the gibbons and great apes.

Most taxonomists and morphologists will find it difficult to agree with Professor Wood Jones in his removal of the Lemuroidea from the order Primates and their inclusion in a separate order with the Tupaiidae, which he removes in turn from the menotyphline Insectivora. Yet there is some justification for such an apparently radical view, even though the author overemphasizes the significance of such characters as the position of the tympanic annulus. Professor Wood Jones has made out a very good case for the inclusion of *Tarsius* with the Anthropoidea (as contrasted to the Lemuroidea). Yet in many respects *Tarsius* exhibits close affinities with the lemurs rather than with monkeys, apes and man. Thus, in view of their uncertain position, it would perhaps be best tentatively to regard the tarsiers as constituting a separate suborder of the Primates, the Tarsioidea. This is the view of many students of the problem.

Professor Wood Jones attempts to show that man possesses a great many fundamentally primitive characters that have been lost by the monkeys and apes. He is fully aware of the many resemblances and even complete agreements in the anatomy of man and the anthropoids. These, however, he dismisses as being indicative, not of close genetic relationship, but of convergence in unrelated forms which, once arboreal, have adopted more or less completely the upright posture, and become more or less bulky in build (page 329). Yet on the previous page in defending the close alliance between anthropoid apes and Cynomorph monkeys, he states that "it is difficult to imagine that the whole series of identical non-adaptive pithecoid features developed, say, in a Gorilla and a Macaque can possibly have been acquired independently." And in defense of his diametrically

opposed reasoning when dealing with the great resemblances between man and anthropoids, the author can only unconvincingly explain that in this case we are dealing with "only a limited homoeomorphy of purely adaptive features." Such reasoning might be justified were it possible accurately to pigeon-hole all such characters as non-adaptive or adaptive. But at the present time, unfortunately, this all too frequently cannot be done. It is one thing to label the great group of resemblances between man and the anthropoids as wholly due to convergence, but it is quite another thing to reasonably prove this. And this the author has not done.

Although Professor Wood Jones seems insistent upon man's independent derivation from a primitive tarsioid form, we finally discover on pages 356–357 that he assumes "the members of the proto-human stock to be forms which had progressed from a primitive tarsioid stage in the general direction of a primitive Gibbon." If this really represents the author's view, then he is by no means as unorthodox as he would make himself appear. In reality his most radical stand is the assumption that the Cynomorph monkeys represent the apex of the Catarrhine trend of evolution, instead of their being an offshoot from near the base of the Old World stem. The author's arguments in support of this thesis are, however, far from convincing.

Whatever attitude one may assume towards Professor Wood Jones' hypotheses, one cannot help but feel that they serve a very definite and stimulating purpose. The present volume shows clearly that the story of man's evolution is far from being a closed and settled one. Much additional work will have to be done before we can hope clearly to trace his ancestry and definitely discover his specific place among the Primates.—William L. Straus, Jr., *Department of Anatomy, Johns Hopkins Medical School, Baltimore, Md.*

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American carnivores. The question naturally arises as to whether there is any place where they may be expected to survive and be available for scientific study in the future.

The National Parks Service believes that predatory animals have a real place in nature, and that all animal life should be kept inviolate within the parks. As a consequence, the general policies relative to predatory animals are as follows:

1. Predatory animals are to be considered an integral part of the wild life protected within national parks, and no widespread campaigns of destruction are to be countenanced. The only control practiced is that of shooting coyotes or other predators when they are actually found making serious inroads upon herds of game or other animals needing special protection.

2. No permits for trapping within the borders of a park are allowed. A resolution opposing the use of steel traps within a park was passed several years ago by the superintendents at their annual meeting, and they are used now only in emergencies.

3. Poison is believed to be a non-selective form of control and is banned from the national parks except where used by Park Service officials in warfare against rodents in settled portions of a park, or in case of emergency.

Though provision is made for the handling of special problems that may arise, it is the intention of the Service to hold definitely to these general policies. It can be seen, therefore, that within the national park system definite attention is given to that group of animals which elsewhere are not tolerated. It is the duty of the National Park Service to maintain examples of the various interesting North American mammals under natural conditions for the pleasure and education of the visitors and for the purpose of scientific study, and to this task it pledges itself.—HORACE M. ALBRIGHT.

AN APPEAL FOR THE COLLECTION OF SHREWS

Why does not one of our mammalogical Nestors write a book that would teach and encourage young aspirants to make and maintain a private collection of small mammals? Many years ago, that literary nonpareil of American zoology, Elliott Coues, wrote an ornithological "Key" that passed a vivid spark to many a juvenile bird lover.

It involves no great expense, to a beginner, to take care of a small private collection of mice or shrews. Before me lies a wooden cigar box, 130 mm. x 165 mm. x 22 mm. deep, inside dimensions. Nested in it, lies a tin cigarette box, 110 mm. x 140 mm. x 15 mm. deep, and, nested in this, lies a smaller cigarette box, 95 mm. x 130 mm. x 11 mm. deep. On a field trip, these nested boxes could be separated to accommodate 10 *Microsorex* in the smallest box; 10 *Sorex cinereus* in the medium box; 10 shrews of the size of *S. fumeus* or *S. arcticus* in the largest. Cost of boxes, *nil*. A beginner could store his incipient shrew collection in such boxes. If the "Camel" label seemed incongruous on some boxes, "Lucky Strike" would certainly describe *Sorex dispar* or *Sorex fontinalis*.

A cabinet tray, measuring 350 mm. x 450 mm., will hold 75 skins of small shrews. A cabinet, holding 12 such trays, will occupy only 3½ cubic feet of space. Such a collection needs little more room than Dr. Eliot's famous library.

The winter pelages of some shrews discovered years ago are still unknown. Possibly various duties have unduly restricted our institutional collectors to midsummer collecting. Without going into details, it is my impression that late winter trapping of shrews, when practicable, has advantages. In general, these little "multum in parvo" mammals seem to offer great research opportunities for young zoologists, lucky enough to be living at some rural crossroads.—MORRIS M. GREEN, *Ardmore, Pa.*

JAMES S. HINE

December 22, 1930, James S. Hine, Curator of Natural History, Ohio State Museum, passed away. Dr. Hine was an entomologist by training but was broadly interested in many fields, and rendered long and valuable service to Mammalogy through his interest and activity in this branch of science. He left behind him a rich collection of notes and records of the mammals of the state covering a period of more than twenty years. As curator he had collected many specimens for study and had undertaken the installation of a series of exhibits following the best museum practice. It is to be regretted that his untimely death cut off publication of much of the material collected but his records and specimens are available and he inspired others to such a degree that the work will go on. For many years two papers by Dr. Hine were about the only thing available on Ohio.

Mammalogy's great debt to Dr. Hine lies in the fact that for many years he "carried on" in Ohio, collecting and encouraging others to collect. With Rev. Henninger he helped to bridge the gap in Ohio from the publication of Brayton's Report on the Mammals of Ohio to the present, adding very substiantially to the store of information. His loss will be keenly felt by the workers in the state and by the Society.—ROBERT K. ENDERS.

VICTOR J. EVANS

Victor J. Evans, life member of the American Society of Mammalogists, died in Washington of heart disease, February 1, 1931. He was born in Delaware, Ohio, on May 20, 1865.

Since 1880 he had lived in Washington where he had established the firm of Victor J. Evans & Company, Patent Attorneys. Always interested in nature, he found time to devote to animal life, and money with which to buy rare and interesting species that he presented to the National Zoological Park. The Glacier bear now in our collection is one of the notable specimens that he contributed.

The five years previous to his death he spent largely in forming a private zoo at Acclimation Park, his estate in Washington. Here he gathered a large collection of carefully chosen birds and mammals, and these by his will were given to the U. S. Government. They are now being transferred to the National Zoological Park. Among the mammals are a fine pair of elands, two gnus, a trio of zebras, and several species of deer.—WM. M. MANN.

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